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Proceedings of the Regional Advisory Meeting on the Review of the Lower Churchill Hydroelectric Generation Project

April 20-21, 2009
Fluvarium
St. John's, NL

Meeting Chairperson
Keith Clarke

Réunion de consultation scientifique régionale concernant l'examen du projet de production hydroélectrique du cours inférieur du fleuve Churchill

Les 20 et 21 avril 2009
Fluvarium
St. John's, T.-N.-L.

Président de réunion
Keith Clarke

Fisheries and Oceans Canada / Pêches et Océans Canada
Science Branch / Direction des sciences
80 East White Hills Road
St. John's NL / St. John's, T.-N.-L.
A1C 5X1

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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made at the meeting. Proceedings also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d'analyses ou d'interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenues dans le présent rapport puissent être inexactes ou propres à induire en erreur, elles sont quand même reproduites aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considérée en tant que reflet des conclusions de la réunion, à moins d'indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l'information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

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200, rue Kent Street
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K1A 0E6

http://www.dfo-mpo.gc.ca/csas/

CSAS@DFO-MPO.GC.CA

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SUMMARY

A Regional Advisory Process (RAP) on the Review of the Lower Churchill Hydroelectric Generation Project was held April 20-21st, 2009 at the Fluvarium, Nagle's Place, St. John's. Nalcor Energy is proposing to develop the hydroelectric potential on the Lower Churchill River, Labrador. As required, Nalcor has developed an Environmental Impact Statement (EIS) for the project. Habitat Management (NL Region) has requested the Science Branch review of specifically identified sections within the EIS and the relevant component studies that either describe and/or predict changes within the aquatic environment. The information from this scientific review will be provided to Habitat Management to help form part of the Department's response to the overall adequacy of the EIS as assessed against the guidelines, which have been agreed upon the by the Government of Canada and the Government of Newfoundland and Labrador, namely whether the specifically identified information items adequately address the corresponding Guideline sections, and if they do not provide a rationale as to why.

Participants included DFO staff from Science (NL and NCR Region), Habitat Management (NL Region), Nalcor Energy, Hatch, Nunatisavut Government, AMEC E & E, Torngat Wildlife, Plants, and Fisheries Secretariat and the Provincial Government.

These proceedings contain a summary of presentations and related discussions held at the meeting. Also included as appendices are the terms of reference, meeting agenda, list of participants for the meeting and technical annexes provided to facilitate the review and discussions. While there have been subsequent meetings and work done to address the topics focused on in this review, the discussions in this proceedings only address the discussion that took place at the April 2009 RAP.

A Science Advisory Report (SAR) was produced as a result of this RAP and contains the conclusions of the science review.

SOMMAIRE

Un processus de consultation scientifique régional (PCSR) concernant l'examen du projet de production hydroélectrique du cours inférieur du fleuve Churchill a eu lieu les 20 et 21 avril 2009 au Fluvarium, Nagle's Place, à St. John's. Nalcor Energy veut exploiter le potentiel hydroélectrique du cours inférieur du fleuve Churchill, au Labrador. Tel que requis, Nalcor a élaboré une étude d'impact environnemental (EIE) pour le projet. Gestion de l'habitat (Région de T.-N.-L.) a demandé à la Direction des sciences de passer en revue des sections précises de l'EIE ainsi que des études connexes donnant des descriptions ou des prévisions sur les changements qui surviendront dans l'environnement aquatique. L'information découlant de cet examen scientifique sera fournie au personnel de la Gestion de l'habitat et servira à élaborer la réponse du Ministère concernant l'à-propos de l'EIE, dans son ensemble, vis-à-vis des lignes directrices sur lesquelles le gouvernement du Canada et le gouvernement de Terre-Neuve se sont entendus, à savoir si les données précisées respectent les exigences des sections correspondantes des lignes directrices et, si ce n'est pas le cas, en fournir la justification.

Parmi les participants, mentionnons du personnel des Sciences (Régions de T.-N.-L. et de la Capitale nationale) et de Gestion de l'habitat (Région de T.-N.-L.) du MPO, des représentants de Nalcor Energy, de Hatch, du gouvernement du Nunatsavut, de AMEC E & E, du Torngat Wildlife, Plants, and Fisheries Secretariat ainsi que du gouvernement provincial.

Le présent compte rendu résume les présentations ainsi que les discussions connexes qui ont eu lieu au cours de la réunion. En annexe se trouvent le cadre de référence, l'ordre du jour, la liste des participants ainsi que les documents techniques fournis pour faciliter l'examen et les discussions. Bien que d'autres réunions et d'autres travaux à propos de ce sujet aient été réalisés par la suite, le présent compte rendu ne résume que les discussions tenues au cours du PCSR d'avril 2009.

Un avis scientifique (AS) a été produit à la suite de ce PCSR et présente les conclusions tirées de l'examen scientifique.

INTRODUCTION

This meeting was convened to discuss the descriptions and predictions pertaining to the aquatic environment that are contained within the Environmental Impact Statement (EIS) for the development of the Lower Churchill Hydroelectric Generation Project. The review was conducted using the information contained in the main EIS documents (Volume 1, Project Planning and Description; Volume 2, Biophysical Assessment; Volume 3, Socio-Economic Assessment and the Executive Summary) as well as supporting Aquatic Component Studies that were provided to reviewers and participants prior to the meeting. Specifically, this workshop focused on the review of identified sections within the EIS and the relevant component studies that either describe and/or predict changes within the aquatic environment, including:

1. Fish and Fish Habitat (11 reports)
2. Water Quality and Quantity (5 reports)
3. Hydrology (8 reports)
4. Mercury (5 reports)

The purpose of this review was to evaluate the science behind these descriptions and predictions to outline any deficiencies. It is important to note that this review dealt with the documentation as it was submitted to the Joint Review Panel (JRP). Therefore, information developed by the proponent since submission cannot be directly reviewed at this time. Deficiencies were assessed against the EIS guidelines agreed upon by the Government of Canada and the Government of Newfoundland and Labrador for this project.

The primary objective of the workshop was to foster discussion and to draw conclusions to address the issues outlined above. Participants were expected to engage in the discussion and contribute to the resultant scientific advice which was provided in the form of a peer-reviewed Science Advisory Report (SAR). The current Canadian Science Advisory Secretariat (CSAS) Proceedings Document provides a record of workshop discussions. The final conclusions of the review and deficiencies identified will be included in the SAR.

The Terms of Reference for the meeting, the meeting agenda, and a list of attendees are presented in Appendices 1-3, respectively.

PRESENTATIONS AND DISCUSSIONS

Much of the following commentary and discussion centered collectively around reviews of the EIS and component studies provided by Becky Sjare (Appendix 4), Bob Randall (Appendix 5), Dave Reddin (Appendix 6), Jim Helbig and Guogi Han (Appendix 7), Bob Gregory (Appendix 8), and Mike O'Connell (Appendix 9).

1. TITLE: Project Description

PRESENTER: Bob Barnes, Nalcor

SUMMARY: Nalcor Energy is proposing to develop the hydroelectric potential on the Lower Churchill River, Labrador. This presentation is an overview of the project description and schedule. Site descriptions and conceptual illustrations of the generation facilities at Gull Island and Muskrat Falls were presented. Other items dealt with the extent of reservoir clearing and the impacts of modeled post-impoundment temperature regimes on sensitive life-history stages of aquatic and terrestrial fauna. Models were also used to evaluate salt water intrusion,

transmission line corridor index, and the 30-yr median ice concentration map of the freeze-up period.

DISCUSSION:

Participants were reminded by the Chair that the purpose of the meeting was to address adequacies, assess EIS Guidelines, and look for deficiencies in the EIS. Information or recommendations from a fisheries perspective were to be examined at a later date and that the current meeting was to focus on deficiencies.

However, concern was raised that the timing of reservoir filling, magnitude of the water drawdown, and location is very important to the fisheries. It was felt that the scenarios put forth are significant therefore comments regarding such issues should be addressed at the meeting.

With regards to the prediction that it will take 37 days to fill Gull Island Reservoir, it was felt that the calculation for filling of the reservoir and determining the amount of water below the dam for the rest of the river needed clarification. There are two options to be examined: filling with no compensation flow; and, filling with a compensation flow of 30% of mean annual flow or 530 m^3/s. There was a question as to whether or not the two options were to be reviewed as part of the EIS review.

Considerable discussion occurred as to whether there is a potential for slumping, e.g., mini-dams to be created, and if the timing of reservoir filling would have an impact on spawning. The reservoir filling time frame would be between late August and early Fall, which means that spawning areas would be lost and fish would have to find other areas. It was proposed by the group that the reservoir be filled in the months of June, July, and August. However it was stated that the process would be considerably longer in those months and could impact nesting waterfowl, the lesser of two evils.

Procedures for drawing water from the reservoirs by the turbines and the locations in the water column where water will be drawn were discussed. It was stated that Muskrat Falls will draw water from the bottom while the depth of intakes for Gull Island will be 23-30 m below the surface.

2. TITLE: Overview of the Review Process and EIS guidelines as they pertain to DFO

PRESENTER: Keith Clarke, DFO Science, Newfoundland and Labrador Region

SUMMARY: The Department of Fisheries and Oceans (DFO) Science advisory process is well established, and provides the basis for policy and management options and decisions. This process, including publication of advice is coordinated through the CSAS, and is an approach that is based on the Government of Canada's Framework for Science and Technology Advice: Guidelines for Scientific Advice for Government Effectiveness (SAGE). This ensures a consistently high standard of technical evaluation while maintaining objectivity, eliminating bias in interpreting results, and that the weight of evidence is assessed with regard to options and potential consequences. Experiential knowledge is evaluated with similar objectivity and rigour through methods appropriate to the type and sources of information, and inclusivity is achieved with a diversity of experts and perspectives who examine all the material.

Science Advisory Reports are the way in which Science advice is formally provided to a client (Sector) and communicated to the public. The SAR from this meeting will outline the deficiencies (from a scientific perspective) of the Lower Churchill EIS. Proceedings capture the

discussions and progression within the peer review or advisory meeting and will also be produced for this event.

Key points to remember for this particular process are that: 1) this is a science review and thus will form Science Branch's advice to Management; and 2) the main goal of this review is to outline any deficiencies within the EIS, where "deficiencies" are based upon the EIS guidelines.

Section 4.0 of the guidelines states that the EIS will describe Valued Environmental Components (VECs) of which the aquatic environment (Section 4.4.4.2) is one, including:

- Identifying the study area and describing the existing resources within this area
- Aboriginal and traditional knowledge of the aquatic environment
- Presenting a time series of data where possible
- Employing confidence limits and/or uncertainty analysis where possible

Section 4.4.5 of the guidelines states that this EIS will produce component studies on:

- Fish and fish habitat (plankton, benthos, marine mammals)
- Water (quality and quantity)
- Hydrology (ice, sediment, salinity and salt water intrusion)
- Mercury (*ecosystem effects* and human)

As previously stated, these are the main focus of this meeting. In general, these component studies should provide the additional data necessary to determine the potential for significant effects on the VEC due to the project.

Section 4.5 of the guidelines states that the EIS will describe the potential environmental effects on the VECs, including:

- Predictions
- Description of cumulative effects (Section 4.5.3)

Section 4.6 of the guidelines states that the EIS will the describe plans to protect the VECs, including:

- Mitigation measures (includes fish habitat compensation, instream flow needs, sediment abatement, reduction of mercury)
- Rehabilitation
- Monitoring and follow-up

Section 2.5 of the guidelines state that this EIS will adhere to the Precautionary Principle, including:

- Demonstration that the proposed project is examined in a careful and precautionary manner
- Outlining the assumptions made about the effects of the project and the approaches to prevent and minimize these effects
- Identifying where scientific uncertainty exists in the predictions of the environmental effects of the project
- Identifying any follow-up and monitoring activities planned, particularly in areas where scientific uncertainty exists in the prediction of the effects of the project

DISCUSSION:

It was noted that some DFO Science participants could not attend the meeting, but that their comments were provided and would be addressed during the discussions and appended to the meeting Proceedings.

Considerable discussion regarding the next steps by Habitat Management would take following the provision of the SAR. It was noted that Habitat Management distributes the EIS to all DFO sectors for comments (e.g., Science, Fisheries and Aquaculture Management, Policy, and Economics). All the information received back, including the SAR, is collected and the position of the Department with respect to the adequacy of the EIS is then drafted by Habitat Management and submitted to the panel.

The SAR resulting from this review will be going to Habitat Management as the advice from Science Branch and a Proceedings document of the meeting will also be produced. Both of these documents will be posted to the CSAS website and made available to the public. A science-based deficiency statement is required from the meeting along with supporting information.

3. TITLE: Marine Mammals and Related Concerns

PRESENTER: Becky Sjare

SUMMARY: For each of the issues discussed, the key criteria from the EIS Guideline document were first identified and presented to the session. Relevant sections of text in the EIS pertaining to that particular Guideline were then evaluated for compliance; a number of deficiencies and/or inadequacies were presented. Some of the issues raised pertained directly to marine mammals (i.e., seals – with a focus on ringed seals) while others touched on related concerns such as marine mammal habitat considerations and trophic dynamics in Lake Melville from a seal predator-prey perspective.

There were several inadequacies in the text on the ***Aquatic Environment (4.4.4.2)*** including the following:

1) Lack of key published literature and local knowledge that indicates Lake Melville may be a relatively unique and potentially important habitat for Labrador ringed seals. Exclusion of Lake Melville proper from the biophysical study is considered a serious deficiency from a marine mammal perspective given ringed seals as well other species are thought to use various types of lake habitats throughout the year and are known to feed on fish species such as smelt that have life stages and migration requirements dependent on Lake Melville.

2) Failure to identify knowledge and/or data gaps pertaining to the ecology of ringed seals as well as several other species of marine mammals that frequent the Lake. For the various species, there are very few or no acknowledged data gaps presented on aspects of abundance, distribution, habitat use, diet or the role these species play as apex predators and yet most (if not all) environmental effects predictions are made with high certainty despite these gaps. Predictions with high certainty are also a problem for a number of other aquatic species where data are lacking, or limited in geographic coverage, or are hampered by short time series and small sample sizes - this is not realistic or acceptable.

For marine mammals and many other aquatic species, there are three related areas of data inadequacy as well as lack of data synthesis that need to be addressed including *trophic dynamics* generally (i.e. predator/prey and general dietary requirements), the importance of finer scale *marine mammal/fish/habitat interactions,* and the identification of *biologically and ecologically important Lake habitats* and their importance from a species life history perspective. If these data are not available, then the ramifications of such gaps need to be acknowledged in the text of the EIS document.

3) Inappropriate presentation of some harbour seal information (i.e. over extension of existing data and unidentified data gaps). It was also noted that text on several of the fish species, including some that are likely prey for ringed and harbour seals in the Lake, suffered from the same inadequacies.

Pertaining to Section 4.4 - The EIS document does not inadequately address the *potential effects of previous projects* (i.e. the Upper Churchill development) and how these effects might interact with this current project. This includes inadequate annotation and evaluation of how 'old' studies were used in the current EIS assessment, and how both 'old' and 'new' data gaps were addressed.

Pertaining to Section 4.5 - The section related to aquatic *cumulative project effects* is seriously deficient in that it lacked detail, scope, project inclusiveness and any integration or synthesis (particularly when compared to the corresponding terrestrial sections of text in the EIS). This is problematic for marine mammals as wells as other aquatic species. It should also be noted that given the scale and diversity of activities associated with this project, 'within' project cumulative effects should also be considered and mitigated.

Pertaining to Sections 4.5 (Cumulative Effects) ***and 2.5*** (Precautionary Approach) - A more comprehensive treatment of climate change effects (including background information, predictions, synthesis and more comprehensive referencing) on marine mammals and other aquatic species is also required to properly develop the proponents presentation on project related cumulative effects. In the case of ringed seals, understanding the drivers of changing winter ice conditions in Lake Melville is important.

Pertaining to Section 4.6 - There is insufficient detail (i.e. scope, objectives, sampling design or methods) presented in the EIS text to properly evaluate any of the *monitoring and follow-up programs presented.* This also means it is not possible for the reader to evaluate how effectively the proponent will be able to validate their environment effects predictions.

DISCUSSION:

Although there were several questions and/or points of clarification pertaining specifically to the 2006 ringed seal abundance survey and possible project related impacts on winter ice conditions, several key points made in the marine mammal presentation became catalysts and provided a larger framework for much of the ensuing discussion period. These issues included the following: 1) the exclusion of Lake Melville proper from the project study area; 2) the high level of certainty associated with virtually all project related effects predictions; 3) data gaps and use of available data (both old and new); 4) inadequate attempt to understand how the effects of the Upper Churchill project might interact with the current project, and 5) the lack of detail in the monitoring and follow-up programs provided in the EIS text. Regardless of the expertise and perspective of the scientists involved, these issues were agreed upon as concerns for most DFO and the Nunatsiavut Government participants at the meeting.

Discussion Specific to Ringed Seals

The survey of ringed seal distribution and abundance conducted in 2006 does provide valuable data on abundance of ringed seals overwintering and pupping in Lake Melville that will be useful for future comparative research. The information on distribution reflects the distribution of animals during the spring moulting period and provides a general idea of the important habitat for overwintering and pupping. However, it does not address the habitat requirements of ringed seals in the Lake Melville region at other times of the year. Ringed seals do use the western end of the lake and Goose Bay at other times of the year. Although we do not have good information in hand to fully evaluate the potential effects of the project from this perspective,

local knowledge does indicate that the Lake is important and from this perspective needs to be included in the impact assessment.

More specifically, from an ice dynamics and ringed seal perspective - the predictions that any changes in thermal and ice regimes of Goose Bay will be localized and small and that the effects further downstream (i.e. Lake Melville) are *likely to be negligible* will be difficult to test/substantiate in the future given the lack of baseline data collected to date, the limited/lack of data to be collected during the EEM program and the issue of not integrating ice into cumulative effects monitoring program (a program which receives virtually no discussion in the EIS document and represents a serious deficiency in itself). Given the significant and rapid changes in ice conditions that local residents have been observing in Lake Melville in recent years, some discussion and more detailed analyses of possible project effects interacting with regional climate change scenarios need to be explored. In particular, the influence of more extreme weather events such as high fall and spring wind conditions and severe spring storms, (all of which could create scenarios where 'small scale changes' in the amount of open water in Goose Bay could potentially lead to more significant changes in the timing of spring break-up and as well as freeze-up), should be addressed in greater detail as this could have both biological and socio-economic impacts (i.e. community sea-ice travel, wooding activities and access to country food resources – not just marine mammals). Notably, discussion and evaluation of these issues is further complicated due to regional climate change also not being adequately addressed in the EIS – an additional serious and related deficiency that needs to be addressed in the study.

Discussion of other Topics of Concern Raised during the Marine Mammal Presentation:

Many of these topics will be dealt with in further detail in ensuing sections.

Exclusion of Lake Melville: A significant number of comments made during this discussion indicated that Lake Melville proper did not receive the comprehensive focus it required in the EIS. In addition to the marine mammal perspective provided, this point was also raised by scientists with expertise in hydrology, fish and fish habitats, mercury contamination and oceanography. The basis of this concern was multi-faceted including acknowledgement that several fish (and marine mammal) species migrate through, forage in and overwinter in the lake habitat. Mercury contamination is a Lake Melville regional concern and needs to be treated as such. In many instances the annual oceanography and hydrology cycle of Lake Melville is so poorly known that it is premature to say with certainty that there will no significant project related effects on the lake proper.

This issue was raised several times in the course of other presentations during the meeting. During this discussion, a request was made that DFO provide rationale for the inclusion of Lake Melville in the project study area for the identified areas of deficiencies. It was agreed that this is an important recommendation.

Certainty of Project Related Effects: There was general consensus by scientists that the significance and level of certainty associated with many of the project related effects were not realistic and not adequately discussed/justified in the text of the EIS document. Some of the factors listed as the basis for this inadequacy, include, the presence of data gaps that were not acknowledged, often heavy and/or somewhat indiscriminant reliance on dated and very short terms studies, and the lack of a well described monitoring program that would be comprehensive enough to flag an emerging problem or concern.

Data Gaps and Data Quality/Inclusion/Annotation: Although this aspect of the discussion covered at least four sub-topics, all were related to aspects of data availability and use. Evaluating the possible implications of data gaps relative to project effects predictions and/or

conclusions was considered to be important by the participants but was rarely included in the text of EIS. From the data quality perspective, there was considerable discussion on whether or not there were adequate caveats in the EIS text to place single season studies with small sample sizes into the proper context for interpretation. In most cases there were not. For example, with respect to the fish species present in Lake Melville and Churchill River, there was a discussion as to whether the type of sampling done in a short timeframe was a good representation of the fish species diversity in the various habitats.

From the data inclusion perspective, much of the meeting discussion focused on the extensive comparative use of the La Grande project in the EIS text. The applicability of this comparison was questioned from a number of perspectives.

From the data annotation perspective, several deficiencies and improvements were discussed – most of these included improving linkages between the EIS and component studies.

Regarding citations and references:

- There are deficiencies in the citations and references in the EIS – some are missing others are incorrect and need to be checked.
- The readability and interpretation of many sections of the EIS text would be significantly enhanced if there was improved referencing of key information within and among the different sections and volumes of the EIS document.
- Those citations and references pertaining to the numerous component studies that are not properly embedded within a sentence or paragraph that provides context and a guide to data interpretation makes it difficult for a reader to comprehend and evaluate the EIS text.

Suggestions as to how to approach this problem included producing an annotated list of the comprehensive studies that described the basic research design and limitations, sample sizes, study duration and key results.

More generally, improving the consistency of reporting important species specific information in the text of the EIS would be extremely helpful for the evaluation of the overall document. The following types of information need to be consistently provided: 1) availability of current data; 2) geographic scope of data; 3) comprehensiveness of the available data; 4) relevance/applicability of data to the current project; and 5) acknowledgement of data gaps. When these data are not available, the text should acknowledge this – particularly if data gaps pertain to the study area. During the course of this discussion a request was made for DFO scientists to identify text, in addition to some of the marine mammal sections, where these types of problems exist.

<u>Understanding the Impacts of Previous Projects – the Upper Churchill</u>

Most participants felt that the EIS did not adequately attempt to report on the changes occurring after the Upper Churchill hydro development – particularly from a cumulative effects perspective. It was noted that pre-60s data for the Upper Churchill project are unavailable with respect to downstream effects. Therefore, the only way to move forward is to try and document changes since that time, learn from them and then evaluate whether there is the potential for interactions with current project related predictions in the future. At least three approaches were suggested including both Traditional Ecological Knowledge (TEK) and Local Ecological Knowledge (LEK) projects as well as preparing a synthesis of existing component studies examining cumulative effects. Based on ensuing discussion it was evident that these types of approaches had not been considered; however cumulative impacts are a part of this review and effects of the development of Upper Churchill should be considered within the limitations of the information available.

Inclusion of Environmental Effects and Cumulative Effects Monitoring

Participants at the meeting were of the opinion that the lack of details pertaining to the environmental effects monitoring program as well as the cumulative effects assessment and monitoring program were seriously deficient. It was recommended that these sections of text be revised to include a clear statement of rationale, objectives, program approach, and adaptive management plans and strategies. Presenting these plans in the EIS was deemed necessary to provide confidence that key project impact predictions can and will be validated or, if they are not, then at least the likelihood of detecting problems will be high enough such that timely mitigative action can be taken.

PLENARY DISCUSSION: Fish and Fish Habitat

It was brought to the attention of the meeting that not all participants had the opportunity to review all parts of the document. It was noted therefore that if comments were not presented, it would be indicated that the specific study was not discussed during the meeting. Additionally, participants were told that if there was anything they wished to review, it could be brought to the attention of the Chair on the following day.

The exclusion of the area below Muskrat Falls both within and beyond the mouth of the river was concerning. It was felt that there is a potential for changes below the falls, due to temperature and other parameters, significant enough to impact fish and fish habitat and therefore this area should be included in the study. It was noted that while there are no baseline data for the Lower Churchill prior to the Upper Churchill coming on stream, there were changes observed by Inuit (LMN) who were familiar with the area. The reason for the proposed delineation was not clear in the EIS.

It was noted that an Inuit knowledge study of the Lake Melville area was not included in the EIS while an Innu knowledge study was included. The Inuit perspective on fish and fish habitat should also be deemed highly important and of great value considering they are major users of the area. Therefore, the exclusion of this Inuit knowledge in the EIS creates a large data gap.

Discussions again highlighted deficiencies as described above (following the Marine Mammals presentation) regarding differences in the types of information in the EIS versus the component studies, and the value of adding linkages between the two for enhanced understanding, as well as highlighting the limitations, assumptions and uncertainties. Specifically, in Section 2.3.7 the limitations, assumptions and uncertainty of multiple gear types needs to be further examined from the science perspective. There is a possibility that errors were created by sampling fish around the shore due to their possible foraging in circular patterns. Although some of the sampling was extensive, the associated assumptions are subject to uncertainty.

It was noted that changes in fish populations can be as important as the changes in fish habitat with respect to the 'no net loss' policy. Therefore, the potential for species to become threatened, endangered, or extinct should be kept in mind throughout the study, reporting, and reviewing processes.

Observations on Lacustrine Habitats:

A deficiency identified during this discussion was the lack of description of instream flow in Gull Lake.

Under the proposed operating regime, based on modeling there will be a 3 m drawdown, and a weekly fluctuation of 25 cm for Gull Island. The potential drawdown has to be examined from all

possible angles and not only the operating regime. It was discussed whether the drawdown regime would cause the reservoir to behave like a lake after 25 years. The reservoir will not behave like any other typical reservoir in this part of the world because of the physics and location. Lower Churchill reservoirs will behave more like run of the river reservoirs rather than lakes; some studies have showed that such reservoirs behave more like river systems than lakes. Therefore the potential effects of a riverine system and not a lacustrine system should be looked into.

Concern was expressed that road access will have significant effects on fishes. With increased access, any resource could be exploited further; a prime example of this is the Star Lake development. Unlike the terrestrial portion of the EIS, fish and fish habitat did not make reference to the potential for overexploitation. These issues should be dealt with in the social sections.

There were a number of comments regarding predicting species composition after inundation. As a result of development, very large habitat change is to be expected, and there will be some species that will fare better than others. An explanation of uncertainties around predictions is needed.

Discussion on the Loss of Spawning Areas and Migration Studies

- It was noted that during the fish migration work only two fish moved into the tributaries to spawn. Thus while not a certainty, main stem spawning maybe occurring at present in the Lower Churchill River. Thus, if adults of the various species in the main stem completely change their behavior post impoundment and spawn in tributaries, they would potentially have to compete with resident species utilizing these areas. Alternatively, fish may not find spawning areas in the tributaries and may not be able to adapt to spawning in the main stem post impoundment. Either situation could result in a potential for recruitment failure. This is an issue that should be highlighted with major uncertainty.

- The EIS did not discuss the potential impact of downstream migration on recruitment. The question was raised whether Muskrat Falls reservoir provided sufficient habitat for species to carry out all their life-history requirements. On the other hand, if recruitment from upstream is important, the construction of dams could compromise downstream areas or result in areas being devoid of fish.

Discussion with Respect to Monitoring Program and Follow-up (see also section below on General Comments for Monitoring and Mitigation)

- This section is extremely small in the EIS and it is recommended that more detail be provided.

- The traditional ecological knowledge of the Innu and Inuit could be used in adaptive monitoring.

- The adaptive monitoring program for the Lower Churchill is not well explained in the present EIS; however, associated issues can be identified in the SAR. The thresholds used in the adaptive management plan could be based on the generation time of fishes for population level triggers.

- It was noted that modifications/adaptations with monitoring have to be focused so that they do not impact the overall intent of the plan. If monitoring plans were to be modified

every couple of years, there would be a risk of monitoring nothing due to a lack of comparability over time.

- The synthesis on existing programs should help with new monitoring questions because it builds on strengths of previous datasets.

- A monitoring period could be based on the generation time of fishes.

Discussion on Sample Size and Year-class Structures

- If the intent is to measure impacts of reservoir creation, then sample size is an issue with respect to analyses of year-class structure, this a major deficiency.

- With respect to fish and fish habitat studies, a major deficiency is that the aging of fish was done using scales for all species. According to the literature, other bony structures such as otoliths, is warranted for certain species.

- With respect to the 2000 and 2006 surveys, the proponent stated that otoliths were collected but not included in the raw data. Otoliths were collected for some species but the sample sizes were small. It was noted that appropriate ageing structures need to be used for baseline data.

- It is difficult for any monitoring program to work without knowledge of age structure for the various fish species. If sample sizes are small, then creating an adequate baseline is going to be difficult.

Discussion on Fish Migration at Muskrat Falls

The issue of Muskrat Falls being at least a partial barrier to migrating anadromous Atlantic salmon and anadromous brook trout was raised. It was suggested that a marking or full migration study would need to be conducted to learn more on this issue. It was mentioned that a radio-telemetry study was conducted for this purpose but participants felt the results indicating no ascent of the falls were not convincing since only one anadromous Atlantic salmon and one anadromous brook trout were used.

It was also reported that work was done in the preceding two years using stable isotopes of carbon and nitrogen as a means of determining whether or not non-anadromous Atlantic salmon (ouananiche) from the area above Muskrat Falls had spent time in salt water. Results showed no evidence of migration to salt water.

Discussion on Salt Water Intrusion

- Salt water intrusion will occur on two occasions, the first during inundation of the Gull Island reservoir which is approx 37 days and the other during the nine-day inundation of the Muskrat Falls reservoir. A 37 day shut-off should not be considered because it could potentially impact 7-8 year classes of fish with effects lasting up to eight to ten years.
- The salt water intrusion will start from the mouth of the Lower Churchill but will not include any tributaries. It will reach its highest point after 14 days. Modeling was based on data for the entire area before Blackrock Bridge was installed.

- Salinity values are actual field measurements. Because salinity is influenced by tides, values for the appropriate time of the year in this regard were used.

- In a number of previous studies conductivity from the mouth to Muskrat Falls was 20 µS/cm and not the considerably higher salinity values of 2-3 PSU obtained from the 1999 survey and used in the salt water intrusion modeling. It was questioned whether or not the CTD used was sensitive enough to detect such low in-river values.

The proponent noted that modeling was conducted by their consultants and that there would be a discussion with them regarding salt water intrusion on Day 2 of the meeting. It was pointed out that clarification is needed to understand the initial conditions that were used and it was suggested that the consultants attend the meeting for further discussion.

Discussion on Depth and Productivity

One of the drastic post-impoundment changes in habitat attributes will be the depth profile. It is uncertain how depth profile change is going to be included in any post-project analysis. All assumptions based on habitat quantification before and after, are based on factors that do not consider depth. This issue is not easily dealt with but needs to be considered because of potential impacts on productivity.

Inundation will restrict the depth of the photic zone from potentially 100% (at present), to the area of the banks which form littoral zones as the reservoirs fill. This will affect production potential. Additional considerations here include the steepness of the slope; drawdown of the water will expose areas of the 'new' littoral habitat available to dry-out.

Other Fish and Fish Habitat Issues Discussed

It is generally a mistake to assume that no fish are found in turbid conditions, when some fish may thrive in this habitat, even though there is no fishery there.

It was stated in the EIS that there were no outfitters in the assessment area. However, there is a sport camp for trout on Minipi Lake, located on a tributary. A concern was expressed that Minipi Lake might be connected to the main stem once the system is flooded to the 125 m level. The proponent stated that this issue was examined and it was determined that flooding would not provide access to this area.

A participant pointed out that the whole system is transitioning from a braided to a meandering river downstream of the development. Braided rivers tend to provide for more juvenile fish habitat than meandering rivers (i.e. channels and sheltered shallows and providing current regimes).

Vegetation Component Studies

The study was quite well done and it was noted that vegetation is very limited (i.e., < 1% aquatic vegetation). There is an absence of mention in the document as to when a stable condition (i.e., delta ecosystems) will be reached once the reservoir is flooded and the vegetation is covered. The type of vegetation may not be conducive for cover for all aquatic species; however, some smaller species may find this useful. It was suggested that hydrological models may be needed to model the stabilization of the delta ecosystems.

The bank stabilization study did not include any of the delta areas or address conditions after flooding. A methods section is required outlining methodology and procedures for clarification purposes.

The deltas will form part of the compensation strategy. The whole premise of the aquatic vegetation study was to determine the species present and their utilization of substrates to aid

in delta recreation. EIS guidelines specifically state that the document should include compensation plans. The proponent stated the present document does not have compensation plans; however, they are currently being worked on.

PLENARY DISCUSSION: Mercury

There are 35 years of data on fresh water studies and systems. In looking at the mercury studies for the identification of deficiencies, the proponent has done a good job of pulling the information together and using that information with most or all of the available modeling approaches to predict the mercury elevation that would result following the reservoir creation.

However, Study 5 in the fresh water mercury sampling promises five appendices, but does not include the first two – which are also not posted on the CEAA website. This information is required to complete the assessment and should be posted. The proponent noted this, stating that the appendixes were sent to the secretariat for posting.

Uncertainties of the approach are clearly stated in the study, and comparisons include several different reservoirs. Therefore, the mercury study has done everything that it should have done for this purpose. However, effects on downstream fish remain lacking.

The mercury study also goes into detail on the consequences of the chopping of fish in the turbine and inducing piscivory in normally insectivorous fish downstream of those turbines. This has been seen in the Quebec turbines and in the Upper Churchill as well. There is some suggestion that the continuing elevation of high levels of mercury in some of the larger fish in Lake Winokapau is perhaps due to the larger fish eating fish chopped up by the turbine.

When the Upper Churchill was flooded, there were elevated levels of mercury in the fish as far as the mouth of the Churchill River. Therefore, it is expected that elevated mercury will be seen downstream of these newly created reservoirs.

The data from a study in the 1970s suggested that smelt populations in Goose Bay have elevated levels resulting from Upper Churchill. The data from 1999 for smelt show a change from 1975-1999. The lower level of mercury in smelt in 1999 suggests that mercury in the 1970s was elevated due to the creation of Upper Churchill. However, other species have not been looked at and may provide valuable information as well.

Similarly for mercury, information pertaining to fish found below Muskrat Falls is a deficiency that has been noted.

PLENARY DISCUSSION: Hydrology

It states in the EIS that there will be no change in the flow, salinity, ice or temperature or other physical disturbance beyond the mouth of the Churchill River. The issue identified by all the reviewers, including hydrology is that there will be physical changes downstream of Muskrat Falls, including the Lake Melville area. There were data showing that temperature regimes would be shifted by 30 days; however, there was no agreement on this.

<u>Discussion on Filling</u>

Only one option for reservoir filling was presented. Other options for the filling and timing should be included in the text and discussed. It was recommended that detailed protocols be presented in the EIS. Reservoir filling has the potential to kill fish, possibly affecting several year-classes. The EIS lacks species-specific information particularly with respect to different

life-stages likely to be impacted. Key information for decision making in relation to timing of filling should be present.

Discussion on Salinity and Sediment Loads

The Churchill River provides most of the fresh water to Lake Melville and also provides a high sediment load. Nutrient and sediment delivery to Lake Melville from the Churchill River is very important to the productivity of the system. Any such changes will alter habitat in Lake Melville the consequences of which are not addressed in the EIS. As an example, in the 1999 DFO workshop on the Lower Churchill, a presentation on the physical and biological oceanography of Lake Melville and the shelf system highlighted satellite imagery of the spring phytoplankton bloom on the coast of Labrador. It was suggested that nutrient loading from Lake Melville to the shelf stimulated the bloom on the shelf. This information was not published but the satellite imagery is available to the public. Therefore nutrient and sediment delivery to Lake Melville from the Churchill River is very important to the productivity of the system.

With respect to the salt water intrusion document, the section of the river between the mouth and Muskrat Falls is below sea level. The compensation flow would be 530 m^3/s, which indicates that there may be some refuges for fish. If there are eggs incubating in these areas during intrusion this year class could be destroyed.

Discussion on Transient Effects

The consultants clarified some points in relation to Helbig's comments on the salt water intrusion model. Firstly, the southern boundary of Lake Melville was used and this is where field data exists. Secondly, if Lake Melville were to be included in model projections, field data for the temperature and salt regime would be required. It was assumed as a basis for the model that the halocline and thermocline would continue to persist during the reservoir impoundment and it was thought that there would be sufficient fresh water from other systems flowing into Lake Melville from other lakes to maintain the surface layer of fresh water.

The input values that were used in the salt water intrusion modeling were questioned. According to the in EIS, the salinity was slightly brackish (2-3 PSU) from the mouth of the river up to Muskrat Falls, based on data taken with a CTD. Previous data showed conductivity in this area to be considerably below this at 20 µS/cm creating uncertainties around model predictions. How would this affect the output of the model? If the salinity had been overestimated in the Churchill River then the salt water intrusion and salt wedge would be 1-2 km farther out than predicted by the model. This creates more uncertainty around the model however if the salt water wedge is further back from the mouth of the river then this is a better situation. The difference of 1-2 km in salt water intrusion would be important for fish species that cannot tolerate salt water conditions.

This issue also arose when the proponent was considering groundwater and consulting with a hydro-geologist about the two units along the edge of the channel (data were for the edge of the channel – a channel that is not always full). Their conclusion based on geological data was that there could be exposed marine sediments that would create different salinity values if data were collected during low versus high tides. In modeling, the worst case scenario was used and all available data were input into the model.

There are different data available from other studies that could be used in the model. It was asked whether it was possible to re-run the models with the new data values. It was responded that cost is an issue and original runs used only the data that were available at the time. However, the possibility of re-runs in light of new data was not rejected.

With respect to questions on the validity of the predictions on depth distributions of temperature, salinity, and currents, it was stated that the model was run in barotrophic and baroclinic modes (Salt Water Intrusion 3D Model Component Study for Aquatic Environment, Section 7.2). It was suggested the methods be made clearer.

Discussion on Water Flow

Presently, the only flow into the mainstem of the Lower Churchill other than that coming from the Upper Churchill is natural flow from the tributaries. There are many variables that influence this such as a dry year or drought and construction schedule. Several compensation flow options were examined. Compensation flow over Muskrat Falls will be relatively easy because it is a low head facility and the spillway is already at existing water level, therefore the flow can be provided without delay. Gull Island will be much more difficult because there is an extended period of time with no flow. Additional information needs to be provided.

The present design does not allow for any flow except natural flow past Gull Island. An option is needed for in-stream flow during the 37 days of impoundment. Habitat Management stated that they would like to see more information regarding other options and the impacts associated with the various options.

There needs to be clarification on the statement in the EIS that suggests that while the amount of water will not change, the delivery will change. The question is whether such change is significant enough to alter the biology or physics.

Discussion on Ice Dynamics

Considerable discussion occurred with respect to the ice dynamic reports and controlling factors during break-up. In some of the 30 year mean maps for the spring break up and freeze up periods in Lake Melville, it would be useful to know what factors keep water area in the area around Goose Bay narrows open. It is unclear whether it is due to the restricted currents in the narrows or to slight changes in temperatures.

The modelers stated firstly that the spatial extent of the modeling in the ice dynamics report was into the mouth of Goose Bay and the concentration maps used were provided by satellite imagery. It was based on 30 year means and there was no modeling or data collection in that area. Secondly, with regards to the factors that keep the water open, it could be speculated that Grand Lake (looking at the May 21 break-up period) is entering at that location, and as ice is dependent on depth and velocity, that could be an influential factor as to the open area at Goose Bay narrows. This is strictly a speculation due to the fact that there was no modeling or data collection in that area.

Participants were unclear as to whether or not the impacts of ice were considered in the bank stability study in relation to erosion. The proponent stated that it was studied but was not included. In the Muskrat Falls there are areas known to have large amounts of sand and the ice could potentially have a big effect on sedimentation.

Discussion on Fish Entrainment

The potential impacts on the fish moving through the hydraulics were referenced in the EIS but more definitive statements could have been made, given there are models describing this. This is an issue because the project will involve several turbines (2-3 different turbines). The EIS stated that fish will be killed when passing through turbines but that it will be a localized effect. In this regard it was suggested there should be a statement on the cumulative effects of

mortality on fish populations over 25 years. There has been a lot of work done on fish entrainment on the Columbia River and this could be reviewed.

From the mercury perspective, the fact that chopped-up fish coming from the turbines are being eaten by other fish (contributing to higher mercury levels) is mentioned in the current EIS.

Fish presently migrate above and below Gull Island. From a science perspective the potential impacts of blocking such movements or the loss of connectivity due to the dam in terms of future productivity for these populations needs to be addressed.

It was pointed out that there is a section on entrainment in the EIS and the general effects.

PLENARY DISCUSSION: Water Quality and Quantity

Water and Sediment Quality

The main discussion on this issue was about the limitations of using data for a single year as a baseline. Because water quality parameters change annually and seasonally, one year/season of substantive data will not give any idea of variance. It was not clear whether 2006-07 was a typical year yet these data were used in modeling exercises. Modeling and extrapolation based on such limited data lead to uncertainty in prediction.

Studies of various ecosystem components were again based on limited data sets. For example, for certain aspects of phytoplankton and zooplankton study, the coefficients of variation (CV) were calculated with sample sizes of N=2.

It was noted by the proponent that real-time monitoring stations have been set up in the river which can be used for comparison with earlier water quality data.

Inter-annual and -seasonal variability in water quality parameters and associated biological and ecological consequences were not dealt with in the EIS which constitutes a deficiency. For instance, changing total suspended loads can affect fish physiology and behavior and such effects would likely be life-stage specific.

Input data for sediment modeling were qualitative and mostly derived from the bank stability study. Parameter values for the calculation of shoreline erosion potential in the bank stability study were qualitative and literature based. Lower and upper values used as multipliers in the sensitivity analysis also came from the literature or were based on professional judgment. Therefore modeling output is subject to considerable uncertainty. However it was agreed that the approach was good.

Sedimentation and Morphodynamics

The EIS did not address the transition from a braided to a meandering river downstream of the development. The implications of this on the aquatic environment and fauna should be fully described in the EIS. There may be a significant change to habitats below Muskrat Falls specifically for juvenile fish because they favor specific habitats.

Sediment Load Analysis

Suspended sediment load and the effects on fish physiology and behavior were not reflected in the document. There is a link between sedimentation and biology and this needs to be listed on a species-specific basis in the existing and future environments. There is evidence and literature that could have been applied to the Lower Churchill in various situations.

Bank Stability

One reviewer stated that the study was effective. However, another pointed out that while the approach may have been sound, there are serious limitations with input data which were qualitative and derived largely from a desktop exercise using values imported from elsewhere as opposed to using data specific to the Lower Churchill.

It was noted by the proponent that validations on material types and substrate distributions are currently being done. While the issues are currently being identified and addressed if they are not included in the EIS we can only discuss them as such.

Other Comments for Water Quality and Quantity

- There should be a discussion on hydrodynamics in the vicinity of the proposed Gull Island dam given that turbines will draw water from around the 25 m depth. It is uncertain how layers will mix seasonally and what effects there will be on fish and mercury in particular and the ecosystem as a whole.

- It was questioned whether residence time of deeper water will be longer than the upper mixing layer in Gull Island Reservoir. If so, the processes in the deep water in terms of mercury and nutrient dynamics are going to be different and this needs to be taken into consideration.

- With water being drawn from the upper layer in the vicinity of Gull Island dam, it was questioned whether or not deep water would become oxygen depleted due to the decomposition of organic debris. This would be important during turn-over.

- The possibility of sediment buildup at Muskrat Falls was questioned. In this regard it was noted that modeling showed a very low sedimentation rate (1m / 100 years).

<u>Discussion of Uncertainties with Predictive Models</u>

<u>La Grande</u>

- *Trophic Upsurge:* Past data for Lower Churchill states that the reservoir is co-limited by phosphorus and nitrogen. If that is the case, trophic upsurge may not occur to the extent that is expected. This will be a significant effect on the ecosystem as it affects the lower tropic levels of the food chain. It is uncertain whether the trophic upsurge seen in other reservoirs in north temperate areas is guaranteed to happen in the Lower Churchill reservoir. In other northern reservoirs where phosphorus and nitrogen are also co-limited no trophic upsurge occurred. Therefore without trophic upsurge there is not a high level of production, which is important in getting though the transition and fluxation. For most of Newfoundland and Labrador, except for the base of the Northern Peninsula where there are highly productive systems, phosphorus and nitrogen are co-limited. Because of this difference between La Grande and Lower Churchill, using La Grande as a predictive model may not demonstrate what might happen in Lower Churchill.

- *Flushing Rates:*
    - Primary Productivity: Flushing rate can have a profound effect on phytoplankton and zooplankton production and species composition. High flushing rates tend to select for faster reproducing and smaller-bodied species. Flushing rate for Gull Island Reservoir is estimated at 28 days and is estimated at 10 days for the Muskrat Falls Reservoir. This is in comparison to 6.9 months for the Robert

Bourassa Reservoir in the La Grande complex. Also unlike the Lower Churchill, the Robert Bourassa has numerous islands which can retain water, thereby increasing residence time. Hence the Robert Bourassa is not a good comparison. The high flushing rates for the Lower Churchill reservoirs also have the potential to remove nutrients and eventually result in levels lower than pre-impoundment levels. The turbine intakes will be in the epilimnion (or mixing layer). Hence, the rate of discharge of this layer could be higher than that attributed to the entire reservoir which has implications for overall productivity as noted above. This can be modeled from a predictive point of view.

  - Two water quality documents, one from 1999 and the other from 2007 (sampling year round) classified the trophic state of sections of the Lower Churchill based solely on phosphorus and not nitrogen. Following the Canadian Council of Ministers of the Environment (CCME) standards and depending on the section of the river, the 2007 study classified baseline phosphorus conditions as ranging from oligotrophic to mesotrophic and mesotrophic to meso-eutrophic. Conclusions from the earlier study that conditions were oligotrophic likely reflect the fact that they used a higher detection level (RDL). Inferring trophic status from nutrient levels in lakes (e.g., in this case the section occupied by Winokapau Lake) alone could be misleading since other factors such as flushing rate can have a profound effect on primary productivity.

- *Flooded Areas:* The Robert Bourassa Reservoir has a very large lateral expanse compared to the long, narrow configuration of the proposed Lower Churchill reservoirs. The amount of land inundated by the Robert Bourassa is huge compared to that proposed for the Lower Churchill. The Robert Bourassa has a surface area of 2,800 km^2, 92% of which covers inundated land. This compares to 40% for the combined surface areas of Gull Island (213 km^2) and Muskrat Falls (100 km^2) reservoirs. Therefore there could be big differences in nutrient quantity and quality.

- *Land Clearing:* There was no clearing in La Grande. However there will be a large amount of clearing in the Lower Churchill with resultant implications for bank stability and suspended material inputs and nutrient supply.

- *Drawdown:* The maximum drawdown in the Robert Bourassa Reservoir is 8 m compared to 3 m for Gull Island Reservoir and 1 m for Muskrat Falls Reservoir; resulting in more stable conditions for the Lower Churchill.

It was noted that the stabilization models are based more on the La Grande than the total suspended solids and total phosphorus simulation study.

It was questioned whether or not there is a system that is more similar to the Lower Churchill than the La Grande. A potential system mentioned was the Williston in British Columbia. It was suggested that the proponent do some comparative work on the configurations of other similar reservoirs to assist in the interpretation of what constitutes a run of river type situation as opposed to a true reservoir. The best example for comparative purposes with the Lower Churchill should be used. Even with similar climatic conditions it was felt that the use of La Grande could not be defended.

The Lower Churchill may be a unique situation therefore direct comparison with other systems may not be possible.

The deterministic model used to predict total suspended solids and total phosphorus used input parameter values for the calculation of shoreline erosion potential that were qualitative and literature based. Values used in the sensitivity analysis also came from the literature or were

based on professional judgment. In light of the qualitative nature of the study and use of imported data, as opposed to data specific to the Lower Churchill, results are subject to a lot of uncertainty.

The literature shows there can be significant spatial (both horizontal and vertical) and temporal heterogeneity in phytoplankton and zooplankton populations. Winokapau Lake, in particular, had a very limited sampling regime. In the primary productivity and plankton biomass study sampling was conducted in only one year at one station with limited seasonal coverage – all of which are inadequate.

General Comments for Monitoring and Mitigation

- The aquatic monitoring is not as developed as terrestrial monitoring. In the terrestrial sections, details are presented as to type of monitoring programs that are going to continue. The reason the terrestrial component has more information is because they do not have permitting components. The compensation process will require an extensive monitoring program that will be controlled by regulatory processes. There are discussions on monitoring that are being held in different forums and are on-going with respect to the Harmful Alteration, Disruption, or Destruction (HADD) of habitat. However, it is a major deficiency that monitoring programs are not well described for the aquatic component of the EIS.

- The EIS guidelines do make mention of follow-up programs, verifying the accuracy of predictions made during the environmental assessment, uncertainties and effectiveness of mitigative measures; however, reviewers were not able to comment given the detail provided in the EIS.

- Specifically in the mitigation part of the EIS, compensation and in-stream flow strategies are not supplied in the document and so reviewers were not able to provide comments. Also, uncertainty associated with the HADD compensation plan was not addressed.

Cumulative Effects and Interactions

- Overall, cumulative effects could be described in more depth within the document, which is a deficiency. All the factors that could impact fish and fish habitat (each rated by impacts) should also be provided.

- Given the duration of the construction phase, the list of foreseeable projects seems short; only the Trans Labrador highway and cultural and land use considerations are in the EIS. In terrestrial sections, commercial forestry and additional transmission line construction are included in sufficient detail.

- Cumulative effects for the terrestrial components were more quantified for the construction phase. The same should be done for the aquatic components.

- In terms of interactions related to aquatic ecosystems, including increased access and changing resource use, the Trans Labrador highway and commercial forestry should be considered for the aquatic section as well. High disturbance activities, such as blasting, need to be considered for cumulative effects. Other projects that could potentially be added to the list include, additional transmission lines, planned mining initiatives, oil and gas exploration, increased vessel traffic, etc.

- An ecosystem component study would have been very useful to anyone reviewing these documents. This is a deficiency not only of this EIS, but probably of most EIS documents.

- In general, long term climate change was not detailed in the EIS. Climate change has the potential to affect the distribution of species and their response to project related perturbations.

- GIS overlays would allow for the identification of effects of other projects and hotspots and of existing projects as an adaptive approach. For example, a decrease in traffic or noise during blasting phases should take into account high impact activities with respect to spawning or other sensitive time periods.

- A flow chart or diagram adapted to the EIS similar to an ecosystem overview would prove useful to the document to show linkages among components.

- More information regarding interaction of fish species could be presented. Some fish are expected to do better than others with predicted habitat changes. There are some qualitative statements on which species will do best within the component studies. Uncertainties associated with this should be stated.

- In the HADD documentation it states post-impoundment, productive capacity will be equal or greater that of pre-impoundment. However, this information is based on the La Grande and may not be appropriate. Literature exists to show that species can be lost during the impoundment of a reservoir.

In summary, the cumulative effects section is deficient and will be highlighted as such in the SAR. It is recognized that it is premature to impose on a proponent the protocols for adding together cumulative effects. This is something, however, that within the timeline of the project can be done. It also has to be accepted that cumulative impacts are more than just the additive effects of the individual impacts. Currently the approach is to be precautionary. This is similar to the climate change issue with respect to on-going research and associated lag time.

Further Discussion on the SAR and Deficiencies

It was decided that text should be added in the SAR regarding the validity of the model predictions for salinity and temperature within Goose Bay. While the baroclinic mode was run in the model it was realized that it was not validated in this mode. This was not to be identified as a deficiency but will be noted in the text of the SAR.

With respect to addressing the construction phase in this EIS, there was no description regarding how building materials would be brought to the site, i.e., boat, rail, Trans Labrador Highway. The handling of large amounts of fuel was not addressed, and this is very important from a fish habitat perspective as it relates to potential accidents and spill.

It is foreseeable that shipping through Lake Melville could potentially occur during winter. If winter shipping occurs in year four of the project, the document should address potential impacts.

According to the EIS guidelines, GIS should be used for mapping for residual effects and/or cumulative effects. Cumulative effects are being referenced in two ways: intra-project (all within the confines of the Lower Churchill project itself) effects and cumulative effects of different projects.

A re-vamp of the annotated bibliography was suggested to make it more detailed and easier to find (i.e. some sections and not the entire document). It was suggested that the proponent think about it as an extended abstract rather than an annotated bibliography.

Below are points made during the discussion of potential deficiencies:

- With respect to the exclusion of the Lake Melville area from the EIS, potential impacts in this area may affect fish and fish habitat (including seals), mercury cycling, circulation factors within the lake (hydrology), etc. Other potential impacts could include those related to the productivity of the system if sediment supply and nutrient supply from fresh water is changed. Therefore the entire area suggest the inclusion of downstream of Muskrat Falls including Lake Melville should be included in the EIS.

- All Aboriginal knowledge on fisheries and fish habitat and other local knowledge should be included in the EIS, especially in light of the bullet above.

- Table 7-4 in Habitat Quantification Fish and Fish Habitat Component Study: 'Changes to fish habitat' should have been included in the Details column, along with 'Loss of fish habitat', 'Changes in fish populations' etc. The area of changed habitat is larger than the area of lost habitat, and has a larger impact on the fishes and the assessment of No Net Loss (NNL). With the addition of 'Changes to fish habitat' in the table, it should be noted that de-watering under the proposed option will likely have an impact between the two dams (i.e. discontinuous dry out). This will be a discontinuous dry/wet area resulting in the potential for no migration in the area between the two dams.

- Limitations, assumptions and uncertainty must be clearly stated and incorporated into the final assessment. It is not necessary to list all such information within the EIS overview documents but it is necessary to supply enough information to allow an informed reader to find such analyses especially when broad statements on potential impacts are being made. Examples can be supplied by the reviewers.

- There is uncertainty that the resultant reservoirs will exhibit the same fish habitat usage patterns as Winokapau Lake, especially in the stabilization period (20-25 years). This needs to be addressed through future monitoring programs which have not been well described in the EIS. More information should be provided surrounding the uncertainly in regards to fish habitat usage.

- Volume IIA, 4, Habitat Utilization, page 4-12: it is good to acknowledge that inundation and reservoirs will advantage 'certain fish species' over others. These species-specific changes can be predicted using science-based methods. However, with the methods used in the EIS, there is uncertainty with the predicted changes in relative ranking of species, existing versus predicted (Table 4-16). This uncertainty should be explicit in Tables 4-16 and Table 4-15 and 4-16. Ranking is not as 'cut and dry' as implied by these tables.

- Sample sizes were low for a number of fish species (regarding aging, diet, fecundity, length, weight, etc.) and/or habitats within the HADD quantification document and component studies. This was also the case for other biological data (plankton and benthic invertebrates). These low sample sizes add a heightened level of risk and uncertainty to any predictions or analyses. Uncertainties related to spatial and temporal (i.e., inter-annual/seasonal) variation were not well described in the EIS. Component

studies for water quality, plankton, and benthic macroinvertebrates lacked adequate spatial and temporal coverage.

- While fish passage at Muskrat Falls was addressed in the radio-tracking and stable isotope studies, it was felt the issue is still not resolved.

- There were a number of reservations with using the La Grande system to predict potential changes within the Lower Churchill system. A more robust comparison may have been made by using more than one large reservoir system from north temperate areas with a variety of flushing rates and morphology more similar to the Lower Churchill. A deficiency statement might also suggest using a variety of systems with various flushing rates.

- Cumulative effects were not well covered in the EIS and a process that at least lists foreseeable impacts would be useful (See terrestrial component and link guidelines). The use of GIS to identify affected hotspots, or residual effects of past projects was suggested.

- There is a need of an adequate assessment of the potential impacts of the operation of facilities on fish mortality and what effects this would have at the population level.

- Instream flow needs both during the filling of the reservoirs and initial start-up should be presented in the EIS. This is a deficiency.

- Potential impacts of climate change on reservoir operations need to be addressed. There was no overview of the regional models that have been developed for Labrador (extreme events in spring/fall). There needs to be more text around the existing and future environments as well as potential effects. The direction of impacts could be related to too much or not enough water. Most of the regional models for Labrador focus on extreme events for next 20-25 years.

- An adequate assessment of the impact of flow disruptions during reservoir filling is required.

- Data gaps and uncertainty in relation to the precautionary principle as per the guidelines should be acknowledged.

General Comments on EIS and Component Studies

- If possible, the assumptions on catch-based utilization indices should be tested. All methodologies have their inherent biases and need to be acknowledged.

- The EIS lists rainbow smelt as pelagic, but this should only be used loosely. Rainbow smelt are limited to the estuary and what is done downstream from this development will have an impact on this species. Rainbow smelt are also important in the food chain for many other species.

- Numerous comments were made regarding the lack of inclusion of information specific to the Lower Churchill for benthic macroinvertebrates. They were mentioned very briefly in the EIS in the generic sense. Issues discussed in relation to the component study include:

- Small sample sizes – the overall sampling effort was inadequate particularly in the case of Winokapau Lake which can be used to predict future reservoir conditions
- Lack of statistical analysis on replicate samples
- Winokapau Lake is important to the future reservoirs in that it will serve as a source of organisms.

- The statement "fishing will be prohibited during the construction phase" is only in reference to the employees of the project (Volume IIA, 4, table 4-10 and does not include recreational fishing.

APPENDIX 1: TERMS OF REFERENCE

Regional Advisory Meeting on the Review of the Lower Churchill Hydroelectric Generation Project
April 20-21, 2009
Fluvarium, Nagle's Place
St. John's, NL
Chairperson: Keith Clarke

BACKGROUND

Nalcor Energy (formerly Newfoundland and Labrador hydro) is proposing to develop the hydroelectric potential on the Lower Churchill River, Labrador. The proposed project will include two dams with associated generating stations. The first of these sites is proposed to be built at Gull Island which will consist of a 99 meter high dam creating a reservoir of approximately 215 km2 and 200 km long. The full supply level of this reservoir will be 125 m above sea level with a generating capacity of approximately 2000 MW. The second site is proposed to be at Muskrat falls and will consist of two dams, 33 meters and 29 meters high respectively and will create a reservoir of approximately 41 km2 and 60 km long. The full supply level of this site will be 39 meters above sea level with an approximate generating capacity of 800 MW.

ISSUE REQUIRING SCIENCE ADVICE

The construction of these generating facilities would alter the aquatic environment of the Churchill River, below Churchill Falls, as well as the receiving environment (i.e. Lake Melville). This alteration would impact on fish and fish habitat, and would require the issuance of Authorizations under the *Fisheries Act*, thus making the Department of Fisheries and Oceans (DFO) a responsible authority under the *Canadian Environmental Assessment Act (CEAA)*.

Oceans, Habitat and Species at Risk Branch (DFO) have requested that Science Branch (DFO) undertake a review of specifically identified information contained in the Environmental Impact Statement (EIS) provided by Nalcor for the Lower Churchill Hydroelectric Generation Project.

This review will focus on the science behind the descriptions and predictions contained within the EIS. Specially, this review will evaluate:

1. The **methods** used within the descriptions and/or predictions of the aquatic environment.

2. The **assumptions** associated with each methodology, to ensure they are adequately identified and described.

3. **Review** any models used for predictions, making sure the level of **uncertainty** is appropriately described and to ensure precaution has been applied.

Science has determined that this advice will be developed and provided through a Regional Advisory Meeting (RAP) process. The information from this scientific review will be provided to Oceans, Habitat and Species at Risk Branch to help form part of the Department's response to overall adequacy of the EIS as assessed against the guidelines which have been agreed upon by the Government of Canada and the Government of Newfoundland and Labrador namely whether the specifically identified information items adequately address the corresponding Guideline sections – and if not why not.

A presentation will be made at the workshop by Oceans, Habitat and Species at Risk staff on the Canadian Environmental Assessment Act (CEAA) and its applicability to the Lower Churchill Hydroelectric Generation Project.

WORKSHOP OBJECTIVES

This workshop will focus on the review of the specifically identified sections within the EIS and the relevant component studies that either describe and/or predict changes within the aquatic environment. The information required for this review can be found in a number of sections throughout the EIS as well as component studies on four broad topics:

1. Fish and Fish Habitat (11 reports)
2. Water quality and Quantity (5 reports)
3. Hydrology (8 reports)
4. Mercury (5 reports)

A complete listing of these reports and relevant sections of the EIS are indicated in the addendum to this Terms of Reference. The relevant sections of the EIS and component studies will be made available on the CSAS website for download to participants. To obtain the username and password please contact me.

The primary objective of this workshop is to have a discussion and make conclusions to answer the questions outlined above. Participants are to engage in the discussion and contribute to the science advice that will be produced as a result of the workshop discussions.

WORKSHOP OUTPUTS

Scientific advice will be provided in the form of peer-reviewed Science Advisory Report (SAR). A CSAS Proceedings document will be produced to record workshop discussions and conclusions.

PARTICIPATION

- DFO Science from several regions and NHQ
- DFO Habitat both regionally and NHQ
- Centre of Expertise on Hydropower Impacts on Fish and Fish Habitat (CHIF)
- Newfoundland and Labrador Hydro
- Province of Newfoundland and Labrador
- Environmental organizations
- Aboriginal organizations
- Academia

Appendix A

Table of Concordance for the Environmental Impact Statement with Guidelines

Final Guideline Section	Where Addressed in EIS
2.5 PRECAUTIONARY PRINCIPLE	Volume IA, Section 9.12 (all); Volume IIB, Section 7.4 (all); Volume III, Section 8.4.1 & 8.4.2
3.1 STUDY STRATEGY AND METHODOLOGY	Volume IA, Sections 9.0-9.12
4.1 EXECUTIVE SUMMARY	Executive Summary
4.3.2.1 Alternatives to the Project	Volume IA, Section 2.5 (all)
4.3.2.2 Alternative Means of Carrying Out the Project	Volume IA, Section 3.7 (all)
4.3.3 Project Description	Volume IA, Sections 4.1-4.8 (all) & 4.11 (all)
4.3.4 Construction	Volume IA, Sections 4.4.1 to 4.4.3 & 4.6.1 & 4.8.2 Volume IA, Sections 4.2 and 4.3 (all) Volume IIA, Section 4.11.1 (all)
4.3.5 Operation and Maintenance	Volume IA, Section 4.5 (all) Volume IIA, Section 4.11.2 (all)
4.3.6 Decommissioning	Volume IA, Section 4.6 (all)
4.4.1 Environment - Identification of Key Issues and Selection of Valued Environmental Components (VECs)	Volume IA, Sections 7.5 & 9.2
4.4.2 Study Areas	Volume IA, Section 9.3 (all) & 9.4 Volume IIA, Sections 2.1 (all) & 2.3 (all) Volume III, Sections 2.3.3.3, 2.8.3.6 & 2.8.5
4.4.3 Previous Development	Volume IA, Section 1.6 &5.1 (all) Volume IIA, Section 2.3.3 (all) & 2.3.7.3 Volume III, Section 4.7.5.6
4.4.4 Description of the Existing Environment & 4.4.4.2 Aquatic Environment	Volume IIA, Section 2.3 (all) Volume III, Section 2.8.3.6 & 2.8.5
4.4.5 Component Studies (e) Fish and fish habitat (plankton, benthos, marine mammals); (f) Water (quality and quantity); (g) Hydrology; (h) Mercury	
4.4.6 Data Gaps	Volume IA, Section 5.4 Volume IIA, Section 2.3 (all)

4.5.1 Environmental Effects - General	Volume IA, Section 9 (all except 9.1.3.9-9.1.3.13) Volume IIA, Sections 4.1-4.15 (all) Volume IIA, Appendix IIA-A-3
4.5.2 Environmental Effects - Accidents and Malfunctions	Volume IIB, Section 6.5 (all)
4.5.3 Environmental Effects -Cumulative Effects	Volume IA, Section 9.9 Volume IIA, Section 4.16 (all) & Appendix IIA-A, Table IIA-A-4
4.5.4 Environmental Effects - Renewable Resources	Volume IIB, Section 7.4.2 Volume III, Section 8.4.2 Volume IA, Chapter 10
4.6 Environmental Protection - 4.6.1 Mitigation, including 4.6.1.1 Compensation	Volume IA, Sections 3.7.11, 4.2.1.3, 4.2.2.3 & 4.8.2 (all) & 4.11 Volume IIA, Sections 4.10-4.12 (all) Volume IIB, Sections 5.10 & 7.1 & Appendix IIB-A, Table IIB-A-30 Volume III, Section 4.7.5.6
4.6.2 Environmental Protection - Emergency Response/Contingency Plans	Volume IA, Section 3.4.1.3
4.6.3 Environmental Protection - Rehabilitation	Volume IA, Sections 4.4.1, 4.4.2, 4.4.3 & 4.6.1
4.6.4 Environmental Protection - Monitoring and Follow-up Programs	Volume IA, Section 9.10 Volume IIA, Section 4.17 Volume IIB, Section 7.3
4.7 RESIDUAL EFFECTS & DETERMINATION OF SIGNIFICANCE	Volume IIA, Section 4.15 (all) Volume IIB, Section 7.2.2 & Appendix IIA-A; Table IIA-A-3
4.10 ENVIRONMENTAL PROTECTION PLAN	Volume IA, Section 4.8.2 (all) & Appendix IB-G
4.11 REFERENCES CITED	Volume IA, Section 11 (as applicable) Volume IIB, Section 8 (as applicable) Volume IIA, References (as applicable) Volume III, Section 9.0 (sections 2, 4 & 8)

Appendix B

Component Studies
Aquatic Environment

Fish and Fish Habitat

1. Aquatic Vegetation Study; AMEC Earth and Environmental Ltd. 2008
2. Seal Abundance and Distribution; Sikumiut Environmental Management Ltd. 2007
3. Habitat Quantification; AMEC Earth and Environmental Ltd. and Sikumiut Environmental Management Ltd. 2007
4. 2006 Fish and Fish Habitat Baseline Study: Catch-based Utilization Index Validation and Additional Habitat Surveys; AMEC Earth and Environmental Ltd. 2007
5. HADD Determination Methodology Churchill River, Labrador; AMEC Earth and Environmental Ltd. 2001
6. Biological Study of the Goose Bay Estuary; Jacques Whitford 2001
7. Fish Migration and Habitat Use of the Churchill River; Jacques Whitford 2000
8. Fish and Fish Habitat; AGRA Earth and Environmental 1999
9. Primary Productivity and Plankton Biomass; Jacques Whitford 1999
10. Benthic Invertebrate Study of the Churchill River; Jacques Whitford 1999
11. Lower Churchill River Fish Consumption and Angling Survey; Minaskuat Inc. 2009

Water Quality and Quantity

1. Water and Sediment Modeling in the Lower Churchill River; Minaskuat Inc. 2008
2. Water and Sediment Quality in the Lower Churchill River; Minaskuat Limited Partnership 2007
3. Sedimentation and Morphodynamics Study; Northwest Hydraulic Consultants 2008
4. Water and Sediment Quality of the Churchill River; Jacques Whitford 1999
5. Water Quality and Chlorophyll Study; Jacques Whitford 2000

Hydrology

1. Bank Stability Study; AMEC Earth and Environmental Ltd. 2008
2. Salt Water Intrusion 3D Model; Hatch 2008
3. Hydraulic Modeling of River; Hatch 2008
4. Ice Dynamics of the Lower Churchill River; Hatch 2007
5. Further Clarification and Updating of the 2007 Ice Dynamics Report; Hatch 2008

6. Aquatic Environment in the Goose Bay Estuary; Amec Earth and Environmental Ltd. and BAE - Newplan Group Limited SNC - Lavalin 2001

7. Sediment Plume Analysis; Hatch 2008

8. Salt Water Intrusion 3D Model Study – Addendum No. 1; Hatch 2008

Mercury

1. Assessment of the Potential for Increased Mercury Concentrations; Tetra Tech Inc. 2008

2. Calculation of Anticipated Consumption Advisory Levels of Fish in the Lower Churchill Area; Minaskuat Inc. 2008

3. Existing Mercury Concentrations in Osprey and Ecological Risk Assessment; Minaskuat Inc. 2008

4. Statistical Analysis of Mercury Data from Churchill Falls (Labrador) Corporation Reservoirs; Jacques Whitford 2006

5. Freshwater Fish Mercury Sampling; AMEC Earth and Environmental Ltd. 2000

APPENDIX 2: PROPOSED AGENDA

Regional Advisory Meeting on the Review of the Lower Churchill Hydroelectric Generation Project

Fluvarium
Nagle's Place, St. John's, Newfoundland & Labrador
April 20-21th, 2009

Chair: Keith Clarke, Freshwater Habitat Research Biologist

Monday Morning April 20th:

9:00 – 9:15	Chair introductory remarks and welcome
9:15 – 9:35	Overview of CEAA and DFO's Role
9:35 – 10:05	Project Description, Nalcor
10:05 – 10:20	Morning Break
10:20 – 10:35	Overview of EIS guidelines as they pertain to DFO
10:35 – 12:00	Fish and Fish Habitat (Plenary Discussion)
12:00 – 13:00	Lunch Break
13:00 – 15:00	Fish and Fish Habitat (Plenary Discussion)
15:00 – 15:15	Afternoon Break
15:15 – 17:00	Fish and Fish Habitat (Plenary Discussion)

Tuesday April 21th:

9:00 – 10:15	Hydrology (Plenary Discussion)
10:15 – 10:30	Morning Break
10:30 – 12:30	Mercury (Plenary Discussion)
12:30 – 13:30	Lunch
13:30 – 15:30	Water Quality and Quantity (Plenary Discussion)
15:30 – 15:45	Afternoon Break
15:45 – close	Discussion on Potential Interactions and the Development of Summary Bullets

APPENDIX 3: LIST OF ATTENDEES

Name	Affiliation	Mailing Address	E-mail	Phone/Fax
Anderson, Robin	DFO Science	NAFC	m.robin.anderson@dfo-mpo.gc.ca	772-0406
Barnes, Bob	Nalcor Energy Lower Churchill Project	Nalcor Energy	bbarnes@nalcor-energy.com	737-1266
Barnes, Marvin	DFO	NAFC	marvinbarnes@dfo-mpo.gc.ca	772-4912 / 772-5567
Biasutti-Brown, Marina	Nunatsiavut Government	Box 909 Station B Happy Valley - Goose Bay NL A0P1E0	mbiasutti@nunatsiavut.com	896-8582
Bieger, Tilman	DFO HMP	NAFC	tilman.bieger@dfo-mpo.gc.ca	772-4029
Bourgeois, Chuck	DFO Science	NAFC	chuck.bourgeois@dfo-mpo.gc.ca	772-2128
Burlingame, Todd	Nalcor Energy Lower Churchill Project	Nalcor Energy	toddburlingame@nalcorenergy.com	737-4251
Clarke, Keith	DFO Science	NAFC	keith.clarke@dfo-mpo.gc.ca	772-2907/ 772-5315
Coffey, Juliana	Torngat Wildlife, Plants, and Fisheries Secretariat	P.O.Box 2050, Station B Happy Valley- Goose Bay	juliana.coffey@torngatsecretariat.ca	896-6780
Dawe, Mary	DFO	NAFC	marydawe@dfo-mpo.gc.ca	772-4102
Dempson, Brian	DFO Science	NAFC	brian.dempson@dfo-mpo-gc.ca	772-4475
Grant, Carole	DFO HMP	NAFC	carole.grant@dfo-mpo.gc.ca	772-2506 / 772-5562
Gregory, Bob	DFO	NAFC	robert.gregory@dfo-mpo.gc.ca	772-4491 / 772-5315
Kelly, Jason	DFO HMP	NAFC	jason.kelly@dfo-mpo.gc.ca	772-8889
Mansour, Atef	DFO CSAS	200 Kent St. Ottawa	atef.mansour@dfo-mpo.gc.ca	613-990-6218
McCarthy, Jim	AMECE & E	133 Crosbie Rd	james.mccarthy@amec.ca	722-7023
O'Connell, Mike	Consultant	St. John's, NL	michaeloconnell@nf.sympatica.ca	745-8815
Organ, Marion	Nalcor Energy Lower Churchill Project	Nalcor Energy	marionorgan@nalcorenergy.com	737-1255
Perry, Robert	Wildlife Division Gov NL	117 Brakes Cove Corner Brook NL A2H 751	robperry@gov.nl.ca	637-2023
Pryse-Phillips, Amy	Hatch	280 Torbay Road St. John's	aprysephillips@hatch.ca	754-6933
Roberge, Michelle	DFO Hbt Mgmt	NAFC	michelle.roberge@dfo-mpo.gc.ca	772-6072
Rollings, Ken	DFO	NAFC	ken.rollings@dfo-mpo.gc.ca	772-2508 / 772-5562
Rosales, Michael	Hatch	280 Torbay Road St. John's	mrosales@hatch.ca	754-6933

Name	Affiliation	Mailing Address	E-mail	Phone/Fax
Sjare, Becky	DFO	NAFC	becky.sjare@dfo-mpo.gc.ca	772-4049
Sutton-Pande, Vanessa	DFO Science	NAFC	vanessa.sutton-pande@dfo-mpo-gc.ca	772-3132
Templeman, Nadine	DFO Science	NAFC	nadine.templeman@dfo-mpo-gc.ca	772-3688
Weagle, Ken	Nalcor Energy Lower Churchill Project	Nalcor Energy	kennethweagle@nalcorenergy.com	737-4218
Woolgar, Robert	Hatch	280 Torbay Road St. John's	rwoolgar@hatch.ca	754-6933

APPENDIX 4: COMMENTS PROVIDED BY BECKY SJARE

Lower Churchill Hydroelectric Generation Project: EIS Guideline Compliance

Specific Comments on Marine Mammals and General Concerns

I) Guideline – 4.4.4 Existing Environment

- *Identification of data gaps and how they will be addressed.*
- *Components of the environment must be described. It shall include necessary data to understand, interpret and address the confidence level of the data.*
- *Describe interrelationships and sensitivity to disturbance.*

Guideline – 4.4.4.2 – Aquatic Environment

- *The proponent shall describe: important habitats found along shoreline and abundance, distribution and population dynamics of species in these habitats.*

EIS – Seals

Ringed and Harp Seals:
The section of text has a number of inadequacies that need to be addressed:

- There is no review of key literature that would indicate that ringed seals of Lake Melville are relatively unique ecologically or that the Lake Melville habitat also appears to be relatively unique, particularly from an overwintering and breeding perspective.

- There is no indication of knowledge data gaps concerning seasonal distribution (other than the on-ice moulting period during the survey), diets, and role as apex predators in the Lake Melville ecosystem, the cultural significance to the residents in the area, and the importance of ringed seals as a country food.

- Harp seals are seasonal migrants, but do warrant a more comprehensive discussion in the text.

- Little is known about bearded seals in the Lake and river systems. They frequently visit the Lake and may venture up rivers and therefore should be included.

The ringed seal survey of Lake Melville in 2006 during the spring moulting period provides very valuable baseline data and will be important for future comparative research from a variety of perspectives. However, it must be emphasized that the survey data *does not* address the habitat use or requirements of ringed seals, or any other seal species, in the Lake Melville region at other times of the year. The survey was designed to obtain an *estimate of abundance* for *only* ringed seals; these data should not be over extended in the ringed seal context or for any other seal species (i.e. harbour seals).

Harbour Seals:

- Existing text should be considered a template for the ringed and bearded seal in terms of the type, organization and comprehensiveness of information presented (not withstanding the noted data gaps).

- It should be made clear in the text that objectives and timing of the 2006 survey was to determine ringed seal abundance and was not appropriate for surveying harbour seals.

- Our knowledge of harbour seals in the Lower Churchill river, surrounding area and Lake Melville is extremely limited; this should be clearly noted as a data gap and addressed as such. In the future, a series of properly designed and timed aerial surveys should be conducted for this species.

- Nationally and internationally, harbour seals are becoming recognized as good indicators of upper-trophic level health in marine systems. This should be discussed and could be important and useful from a future monitoring perspective – particularly from a mercury perspective.

There are some problems in the translation of Innu seal species names. This should be corrected. It is unlikely that hooded seals frequent the western areas of Lake Melville.

Conclusions and General Comments on Existing Environment Text:

For all seal species, there are compliance issues that need to be addressed. More generally, for many of the fish species, the following issues are problematic: a) inconsistency in the type, scope (geographic extent) and presentation of data; b) little delineation of what information is based on studies from the region vs. elsewhere; c) minimal or no synthesis of what data is presented; and d) usually no indication of knowledge gaps.

2) Guidelines – 4.4.2 Study Area – exclusion of Lake Melville from Assessment Area – marine mammal perspective

- *The proponent shall determine study areas specific to each VEC and should be inclusive of the landscape necessary to predict the environmental effects of the project. The rationale used to delineate the boundaries shall be provided.*

EIS – Seals

The information presented on ringed and harbour seals along with the identified data gaps identified above (particularly those pertaining to seal diets and seals as apex predators) provide justification for the need to include Lake Melville in the assessment area.

Although there is little information available on ringed seal diets, it is thought that smelt are important.

There are several other key fish species that have various life stage and migration requirements dependent on Lake Melville – again, justification for the need to include Lake Melville in the assessment area.

In addition, in Section 2.8 – 'Land Use' in Vol. III of the EIS, significant negative project related effects have been predicted for the greater Lake Melville *region* including changes in resource access (i.e., reduced fishing and hunting of many country food and culturally important species

such as ringed seals), over-utilization of country food resources, and regional changes in traditional land-use practices. Also, see comments (in Discussion on Mercury) on the need to monitor mercury levels in the Lake Melville food-web (including seals as apex predators). Again, all of these issues are justification for the need to include Lake Melville in the assessment area.

3) Guidelines – 4.4.3 Previous Developments

- *Understanding how the effects of past hydroelectric projects have been mitigated and/or managed.*
- *It should provide a concise discussion of the environmental effects that have resulted.*
- *It should indicate where overlapping environmental effects are anticipated and the measures that have been taken to mitigate or manage them. It should also provide an indication of how successful they were.*

EIS – General Comments

This is a comprehensive section in the Guidelines and although it is not possible to address all the criteria to the same level of detail, the appropriate sections of the EIS text is inadequate in terms of compliance.

There are detailed descriptions of the prior hydro developments, but little discussion on the environmental effects that have resulted. This deficiency could be at least partially addressed in several ways:

1) A summary of the relevant 1980 review panel findings and a summary of what studies (if any) were completed to address the data and knowledge gaps identified by the panel.
2) Although an annotated bibliography of the component studies is provided, there needs to be more evaluation of which studies (many of which where 1-year or 1 season studies) are still relevant today, which might provide the basis for longer-time series etc., and which studies might address the question of incremental environmental effects of prior developments.
3) The ITK study lays the groundwork for further more detailed work on determining the timeline of environmental change after the Upper Churchill became operational. LTK (local traditional knowledge) of non-aboriginal, longtime residents of the upper Lake Melville region should also be documented to provide an alternative perspective on the environmental effects of the Upper Churchill. In the future ITK and LTK should be used to suggest and direct new research studies.

The requirement to understand the impact of previous hydro development in the spirit of the Guidelines is also compelling justification for including Lake Melville in the assessment area.

4) Guidelines – 4.4.6 Data Gaps

- *Information gaps from a lack of previous research or practice shall be described.*
- *There needs to be acknowledgement of data or data sets which should not be extrapolated over four seasons.*
- *If extrapolation methods are used, they should be described and levels of uncertainty provided.*

EIS – General Comments

The failure of the EIS document to identify data gaps and to acknowledge the potential importance of these gaps is a serious deficiency throughout the document. This is even more problematic when most, if not all, predictions are made with high certainty despite the paucity of data. This is not realistic or acceptable given the scope of some of the data sets available, the passage of time between studies, and the small sample sizes for many of them.

Specific data gap issues with marine mammals have been noted above, but there are numerous other sections of text on a variety of aquatic species and ecological topics that suffered the same problems. These sections of text should be reviewed and the deficiencies addressed.

Three related, but very important, areas of data limitation appear to be ***trophic dynamics*** generally (i.e., predator/prey and general dietary requirements), the importance of finer scale ***marine mammal/fish/habitat interactions,*** and the identification of ***biological and ecologically important habitats within the Lake*** and their importance from a life history perspective. These are serious inadequacies throughout most of the EIS text and need to be addressed particularly from the perspective of DFO's commitment (as well as those of other national and international scientific bodies) to ecosystem-based science, the precautionary approach and integrated management initiatives. These commitments also require that DFO clients requiring science advice move in a similar direction as well.

The extensive use of the La Grande project in North Quebec as a 'model' for predictive and comparative purposes throughout the EIS requires more justification and critical evaluation. There are cases (e.g., benthic invertebrates) where making direct inter-study comparisons are problematic and could be erroneous. These situations should be identified. If a run-of-the-river impoundment would make a better comparison – why was this approach not considered in appropriate circumstances?

5) Guidelines – 4.5.1 – Environmental Effects

- *Environmental effects predictions shall be explicitly stated and the theory or rationale upon which they are based shall be presented.*

EIS – 4.3 Interaction of the Project with Fish and Fish Habitat

Although the proponent does provide rationale for the screening process, it is not adequate without further qualification.

e.g., 4.4 – Construction – Vol 1

The construction phase will have the greatest potential for interactions with the existing environment, yet almost all project activities and physical works are identified as 1s and therefore considered well understood, subject to regulatory measures and can be mitigated and all are rated as not significant with no further need for assessment.

Even though an activity is subject to regulatory measures, this does not ensure there will be no residual effects. The scope, timing and magnitude of some of the construction activities (based on the descriptions in the EIS) strongly suggest that this rationale and its implications be re-evaluated.

6) Guidelines – 4.6.4 Monitoring and Follow-up Programs

- *This shall describe the follow-up programs.*

EIS – General Comments

The EIS document does state that the existing text is only intended to outline the approach; however, even with this caveat, there is insufficient detail (i.e., scope, objectives, sampling design or methods) presented to properly evaluate any of the monitoring and follow-up programs. This means it is not possible for the reader to evaluate how effectively the proponent will be able to validate their environment effects predictions. Although this deficiency does not apply directly to marine mammals since there were no significant bio-physical project related effects predicted and therefore no monitoring program planned, it may, however, be important from a key fish prey and seal perspective. This lack of detail is problematic throughout most of the text dealing with the various fish species and habitat issues and needs to be addressed throughout.

7) Guidelines – 4.5.3 – Cumulative Effects

This section shall:

- *Present changes to the environment due to the Project that overlap, combine or interact with the environmental effects of other existing or reasonably foreseeable projects or activities.*
- *Identify and justify VECs; examine likelihood, nature and extent.*
- *Present justification for special boundary.*
- *Describe and justify the choice of projects.*
- *Describe mitigation measures feasible, and the significance of residual effects.*

EIS – 4.16 – Cumulative Effects

The section related to aquatic cumulative project effects is seriously deficient in detail, scope, project inclusiveness and any integration or synthesis (particularly when compared to the terrestrial sections of text in the EIS). The text is two pages (pp. 290-292) in length *including the text on Monitoring and Follow-up* and certainly does not address the Guideline criteria in sufficient detail. This is, along with the lack of a reasonably detailed monitoring and follow-up program represents a serious deficiency.

- Given the duration of the construction phase of the project, the list of 'foreseeable' projects is short – only the Trans Labrador Highway (TLH) and cultural and land use are considered. In the terrestrial sections, commercial forestry and additional transmission line construction are also included. In terms of interactions with aquatic habitats and the question of increased access, changing resource use and potential over exploitation on a regional scale, these projects and related activities should also be included for the aquatic section of the text as well.

- Are there other projects that should be considered for the project list – for example, planned mining initiatives, gas exploration (i.e., vessel traffic in Goose Bay)?

- Although qualitative, the treatment of all aspects of cumulative effects (including effects on animal health and mortality) is addressed in significantly more detail for the terrestrial environment and the text is useful. The increased attention for the Redwine caribou herd is required and justified given its endangered status. However, the other

discrepancies between the aquatic and terrestrial sections need to be addressed and justified.

Although cumulative effects are generally thought about from the perspective of overlapping effects from two or more different projects, given the scale and diversity of activities associated with this project, 'within' project cumulative effects should be considered and mitigated. This is particularly the case for high disturbance activities such as blasting. Again, in the terrestrial section there are specific statements about timing activities to minimize 'within' project disturbance and disruption – but, nothing in the aquatic section of the document.

Cumulative Effects - Impact of Changing Resource Access in the Lake Melville Region; the community of Rigolet is already seeing over-utilization of many river fish stocks and significant changes in land use practices associated with trapping and wooding. These changes are primarily attributed to improved access of snowmobile trails, a generally more affluent population (e.g., allowing larger boat/snowmobile purchases) and changing hunting practices (i.e., more intense resource use in more localized areas). It is likely that the influx of more money and people in the Lake Melville region associated with this and other projects will only continue to increase this trend placing more pressure on natural resources in the region. Note that, based on Section 2.8 – Land Use in Vol. III (Socio-Economic Assessment), these are identified as significant predicted project effects.

This is further justification, and perhaps one of the most important, for including Lake Melville in the bio-physical and socio-economic assessment region.

Climate Change:

- In general, ongoing and long-term climate considerations received little attention in the EIS; this inadequacy needs to be addressed.

- Section 5.5 (Vol IIB -terrestrial) – Likely Future Environment – In this section it is noted that increased human activities and associated effects on forest cover, in combination with climate change, may affect the distribution and/or abundance of several species of wildlife. In Vol IIA (aquatic) effects of climate were only mentioned briefly, were vague, lacked any synthesis and were poorly referenced. .

- There needs to be an indication of which regional models were being looked at and they need to be fully referenced. The validity and scope of the general statements made in the EIS indicating that there will be relatively little change in the climate for the next 100 years are dependent on the definition of 'relative' and what models are being used. Forecasting the direct and cumulative effects of climate change is difficult, but a more comprehensive treatment of potential effects (including background information, predictions and synthesis) is required to properly develop the proponents presentation on project related cumulative effects.

- From a ringed seal perspective, understanding the potential synergistic effects of climatic and anthropogenic changes on Lake Melville ice dynamics is important.

- Other possible considerations:
    - reservoir regulation from an extreme weather perspective.
    - increase in potential forest fires.
    - interaction with project interactions related to mitigating stream crossings, river forges etc.
    - fish survival in tributaries during hot, dry periods.

APPENDIX 5: COMMENTS PROVIDED BY BOB RANDALL

Lower Churchill Hydropower Generation Report – Environmental Impact Statement

General:

Documentation for the Lower Churchill River (LCR) EIS was extensive and comprehensive, but also sometimes piecemeal and redundant between sections. Brief comments on sections that were read are given below. Specifically, the Methods, Assumptions and Models used for predictions were addressed, particularly as they relate to Uncertainty and Precaution, as outlined in the Terms of Reference. Undoubtedly some of these queries/concerns could be answered with a more comprehensive review. The sections covered were Executive Summary, Volumes I and II, and component studies (HADD, quantification of habitat, and the Fish and Habitat Baseline Study).

Executive Summary

- Under section 7.1 of the executive summary, it is noted that the thermal regime, ice breakup pattern and depth below Muskrat Falls will change post-reservoir development. Later (Volume II A), the habitat area below Muskrat falls is quantified in Table 2-8 and 4-10 (slow and fast velocity; 6327.75 and 48.44 ha respectively), but it is not included in the estimate of existing and predicted habitat within the assessment area (e.g., IIA, Table 4-17). The latter table only quantifies the habitat areas above the Muskrat and Gull Island sites. Confirm whether or not the impacted area below Muskrat Falls was included in the assessment – if not, it should be because of the predicted changes in habitat quality.

- Similarly, Lake Melville was excluded from the Assessment Area (Part IIA, page 2-16). Is it realistic/premature to conclude there will be no effects beyond the mouth of the Churchill River? Outflow effects on marine habitat are a concern elsewhere (see for example the Centre of Expertise on Hydropower Impacts on Fish and Fish Habitat (CHIF) list of priority research, which includes estuaries). Were Aboriginal people involved in the decision of Assessment Area?

- See page 9-9, section 9.1.3.1 of Volume 1A. The hydraulic modeling of the estuary was done, but it was decided to exclude this area because of no anticipated effects?

- Section 5.3 summarizes the Assessment Methods. Additional key information should be included. For example, it was concluded that the assessment of HADD and NNL can be based on 'productivity related values' as related to surface area of habitat types. That is, composite habitat utilization indices are multiplied by habitat area to determine loss and net gain of productive capacity (Report 5, HADD determination, Table 4.1, page 27). Area becomes the dominant influence in this product, and the larger the reservoir area, the greater the potential net gain (see comments in the HADD section below). Also, habitat use by fishes in the lower Churchill River does not appear to be typical of literature values. Hence suitability was determined using catch data, complemented with literature data if needed. Both of these components of the Assessment Methods should be highlighted in the Executive Summary.

Volume 1A

IA 4 – Project Description

- No comments, but note that the development of access roads on the north side of Churchill River will potentially increase fishing pressure over time

IA 5 – Data gaps

- The use of ITK in this report is strongly supported. In future, more time should be spent to document Aboriginal knowledge on fish distribution, seasonal habitat use etc. (to address the comment in section 5: '*Time constraints, as noted in various places throughout this report, posed the major limitation on the amount of environmental knowledge that could be elicited from the ITKC members*'). Inclusion of Aboriginal/Innu knowledge on fish distribution, fishing, and habitat strengthened this report immensely and any additional effort to document this knowledge would be invaluable.

1A 7 - VECs

- Table 7-4, page 7-8: 'Changes to fish habitat' should have been included in the Details column, along with 'Loss of fish habitat', 'Changes in fish populations' etc. The area of changed habitat is larger than the area of lost habitat, and has a larger impact on the fishes and the assessment of No Net Loss (NNL).

1A 9 – Knowledge base

- In Volume IA, Chapter 9, section 9.1.3. 8, pg. 9-11, it is stated that the McCarthy et al. (2006) was peer reviewed and 'endorsed' by Smokorowki and Derbowka (2007; should be 2008). The technical report provided a summary of methods with no scientific review (as stated in the Abstract). It is not clear what 'endorsed' means in the context of the LCR EIS. There was no CSAS Science Advisory Report generated from the Calgary meeting.

- Table 9-1, page 9-15 should include quantification of areas by habitat types (i.e., littoral, profundal, slow intermediate and fast velocity, main stem, tributary and stream) as Measurable Units, since the habitat types were instrumental in measuring suitability. Similarly, changes in habitat quality should include substrate, depth, velocity as well as the water quality measures listed. The Measurable Parameters in this table did not match what was later used to determine the utilization indices.

Volume IIA

- Section 2.3.1.1: Although it states that 'The ecological boundary of the assessment is therefore restricted to those fish populations that reside within the main stem and accessible tributaries of the main stem of the Churchill River from Churchill Falls until the mouth of the lower Churchill River at Goose Bay' (shown in figure 2.2), the lower river reach (Muskrat to Goose Bay) seems to be excluded in some of the analysis (e.g., Table 4.17). It is also stated that tributaries below Muskrat Falls will not be inundated, and are therefore not included in the Assessment Area. However, the habitat (e.g., thermal) will be affected, and will likely impact on migration patterns, etc. Therefore the tributaries and lower reach of the river below Muskrat Falls should be included. Have I misinterpreted the geography and scope of the Assessment Area?

- Figure 2.3, page 2-18 shows a significant change in the flow regime at Muskrat Fall, post-Churchill development. This would affect all downstream reaches, confirming the need for inclusion of all tail waters and the estuary.

- Table 2.8, page 2-28: See comments in Executive Summary regarding this table.

- Section 2.3.7, page 2-50: extrapolation of fish habitat suitability curves from one area to another is known to be risky (uncertain) in the scientific literature. The habitat suitability curves need to be calibrated with the Labrador catch data. This is a strength of this EIS. However, limitations, assumptions and uncertainty of using multiple gear types and limited sampling must be clearly stated and incorporated into the final assessment.

- Table 2.9: For lacustrine habitat, do reservoirs get the same habitat use indices as natural lake habitat (e.g., Winokapau Lake)? Habitat use in reservoirs will likely be different than in natural lacustrine habitat. Regional scientists with expertise on reservoir habitat should have input on this topic. Is the value of reservoirs being overestimated in this report?

- Volume IIA, 4, table 4-1 (Interaction). Road access can have an important effect on fishes (exploitation) that must be managed. Fishing will be prohibited during the construction phase; hence the rank of 1 seems reasonable. However, during the Operation and Maintenance phase, 'Access Roads' should be ranked as 2. See also section 4.16.3.2. Science literature indicates exploitation can have a big impact on populations, sometimes more so than changes to localized habitat.

- Volume IIA, 4, Habitat Utilization, page 4-12: it is good to acknowledge that inundation and reservoirs will advantage 'certain fish species' over others. These species-specific changes can be predicted using science-based methods. However, with the methods used, there is uncertainty with the predicted changes in relative ranking of species, existing versus predicted (Table 4-16). This uncertainty should be explicit in Tables 4-16 and Table 4-15. Ranking is not as 'cut and dry' as implied by these tables.

Volume IIB

IIB – 5.10 Mitigation/compensation
- Regarding access roads, see I A – 4 above

IIB - 6.5 Environmental Effects
- agree with Table 6.4

IIB – 7 Conclusions, sustainability
- no comments

IIB – Monitoring
- Table 7-3, Aquatic Environment: should indicate timelines for monitoring, based on the generation time of the fishes

- 7.4 Uncertainty in the fish-habitat models is not properly quantified. In this context, the limitations listed in McCarthy et al. (2008) are relevant.

Habitat Quantification

- General comment: there are 3 basic steps in determining habitat productive capacity:
  1) Development of a habitat inventory
  2) Assignment of habitat suitability (use) indices
  3) Translate the HUI values into units of production or yield (kg/ha/yr).

- Because of the complexity and cost, Step 3 is usually not included in assessments. For this EIS, of the remaining 2 steps, I am most comfortable with the work done for step 1 (habitat inventory = habitat quantification). For assessing habitat in large scale, whole system areas like the Lower Churchill, the identification of broad habitat types (as in Table 2-8) is sufficient. I am less confident of step 2, as noted below. Sample sizes were small for some species and habitats, leading to risk and uncertainty.

HADD Determination

- Background, pg. 1: As noted earlier, the statement 'One of the key conclusions of the workshop included agreement that HADD determination can be based on "productivity related values" as related to surface area of habitat types' is very significant. With the creation of reservoirs, large areas of new aquatic habitat are created. Regardless of the habitat use indices assigned to this habitat, the large area will usually be the dominant component in the product to determine Habitat Equivalent Units (e.g., Table 4.1, page 27). Accepting the conclusion above means that credits are given for the large reservoir area created for determining NNL, and the results will usually indicate a significant net gain (e.g., Table 4.13 and 4.15 in Volume II A).

- Section 2.2: Habitat Classification: The use of broad/coarse classifications for riverine and lacustrine habitat in this assessment was agreed upon (see habitat quantification above). Also, given the enormous spatial scale, the quantification by habitat type (ha) appears to be reasonable.

- Section 3.2.2, pg 12: It is not clear how the limitation 'It is only possible to sample within each habitat where the gear could be deployed' was addressed.

- Section 3.2.2.1 Mean catch-per-unit effort: The intent of using the upper 95% CL is understood. However, catch data are usually not normally distributed, as noted in this section. Fish distribution is often contagious, not random. Although the authors 'assumed that the 95% CL estimated for the samples is representative and valid for purposes of calculating Catch-based Utilization Indices (C.U.I.) values', this assumption needs to be tested and validated for all habitat types. As it stands, this assumption results in uncertainty. Would it not be preferable to use transformed catch data (e.g., log (x+1)? CLs from re-transformed data would be greater than CLs from untransformed data.

- Section 3.2.3 Catch-based Utilization Indices: Calculation of CUI was both gear and habitat type dependent. It is not possible to differentiate between the habitat effects and the gear catchability. This is a particular concern where only one gear type was used. For example, in Table 3.4, a CUI value of 0.01 was selected for adult brook trout inhabiting slow velocity main stem habitat, based on catches from a single gear (gillnet). Did this low CUI result from low use of this habitat by trout, or from a low catchability (q)

of the gill nets? Without examining the data more thoroughly, it is difficult to judge the limitations (potential bias) of this approach.

Fish and Fish Habitat

- Many of the comments above relate to the data described in the Fish and Fish Habitat components studies.
- Much sampling has been done, with a variety of gear types. The sample sizes were sparse for some areas, habitats and species, in part due to the low productivity of waters.
- Length-weight regressions used to calculate weight for fishes not weighed in the field were sometimes based on very small sample sizes (Table 2.3).
- Further evaluation/calibration/validation of the use of catch data to determine habitat use and suitability is the area that requires further assessment and discussion in this science assessment.

APPENDIX 6: COMMENTS PROVIDED BY DAVE REDDIN

- Muskrat Falls is listed as a complete barrier to migratory fish species present in the lower part of Churchill River. I have seen Muskrat Falls and in my view it is possible that elvers (juvenile eels) would be able to pass above Muskrat Falls. However, eels may not be found there in abundance as they do not occur in Table 2.6. Eels do occur in many Labrador rivers but apparently in low numbers.

- For the other diadromous fish present in the area I would think that Muskrat Falls is at least a partial barrier to migrating adult salmon and sea trout. In Fish and Fish Habitat 7, no conclusions could be drawn regarding salmon migration as no salmon were tagged downstream of Muskrat Falls (see p.86). This would seem to be a deficiency in the study.

- A couple of rivers in the lower portion of the Churchill have been left out, namely, Caroline Brook which has anadromous Atlantic salmon.

- There are no population estimates available for rivers draining into Lake Melville. Thus, conclusions of there being "a small migration" of Atlantic salmon on p. 24 of S2.4, in the area based on recreational and commercial fisheries data is over-stated.

- There is no commercial net fishery for salmon in Lake Melville and thus where there is a lack of data and no conclusions can be drawn. The recreational fishery is limited due to the turbidity of the water and the freshwater nature of the surface waters of Lake Melville so again only limited conclusions can be made from recreational data or the lack thereof.

- There are known migratory populations of salmon in Kenemish, Kenamu, Traverspine, MacKenzie, and the four or five large rivers draining into Grand Lake in addition to rivers on the north side of Lake Melville. Examination of catch rates from the food net fisheries in the area would suggest that moderately sized salmon populations could exist. Without a population study it is impossible to comment on the potential magnitude of the runs in upper Lake Melville area.

- In Section 2.6, p.45 on Fisheries, there is no mention of the extensive native and resident food net fisheries in the lower Churchill River and surrounding area. Also it states there are no commercial sport fishing camps on the river. There is a sport camp for trout at Minipi Lake which is a tributary of the middle Churchill River.

- In Fish and Fish Habitat Report 8, Atlantic salmon were characterized as ouananiche. On what basis were the fish determined to be ouananiche rather then migratory salmon?

- In Table 4.3, catch per unit effort data is shown for various sampling techniques. The results from Baited Trawl should be expressed as fish per hook-unit time rather then (fish/net-trawl).

- The contention that there is no net habitat loss or alteration is not accepted. The lower sections of the river and lower sections of tributaries will be flooded which will alter the type of habitat considerably from what it now is. There will be more fish habitat as the area will be larger than at present but not necessarily of the same type.
- I was unable to find discussion of the effects on the migration corridor for Atlantic salmon and sea trout into the 4 or 5 tributaries downstream from Muskrat Falls. As shown in the EIS, the water flows will be less variable than what they presently are. The higher flow rates commonly experienced in the spring will be reduced from present spring rates

which are a reduction from what they would have been prior to construction of the Smallwood Reservoir. The lower part of Churchill River is almost entirely silt/sand substrate with migration channels being opened up in the spring breakup period of higher flows which washes the silt out leaving behind deeper channels for migratory fish. Without the periodic washouts, the river will become shallower with a potential loss of these migration corridors that allow salmon to access the brooks below Muskrat Falls and their spawning areas. These migration channels should be deemed critical habitat as without them, the migratory salmon and trout populations would not exist. The amount of sedimentary material being transported by the system will likely increase due to bank erosion and slower moving currents. Some of it will inevitably be deposited in the lower part of the river.

- With the reduction of the higher spring flows, will the migration channels still exist that allow for migration of returning adult salmon and sea trout to exit Lake Melville and then move into their tributary streams and upriver to spawn.

APPENDIX 7: COMMENTS PROVIDED BY JIM HELBIG AND GUOGI HAN

Physical Oceanographic Review of the Lower Churchill Hydroelectric Generation Project EIS

From an oceanographic perspective, this EIS should address any possible long-term or transient effects on water properties in Goose Bay, Lake Melville, and Hamilton Inlet resulting from dam operation or construction. These properties should include temperature and salinity as well turbidity and dissolved chemicals, especially mercury in its various forms. The EIS should also discuss any localized effects that might occur, e.g., changes to the Churchill River plume in Goose Bay.

Long-term Effects

In Volume IIA (Page 2-16) Nalcor states that (emphases in bold italic)

- ***Lake Melville is not included within the Assessment Area*** as there will be no change in flow or salinity, water temperature, ice or other physical disturbance beyond the mouth of the Churchill River from this Project. ***In support of this statement, the predicted extent of effects at the mouth of the river has been provided in appropriate sections of this assessment*** (Chapter 4)."

- In fact, however, the discussion of oceanographic effects in Chapter 4 is very limited and consists mostly of citing contracted modeling studies (especially Hatch 2008a – Salt Water Intrusion 3D Model Study).

The Executive Summary (page 22) states:

- As the Churchill River is currently regulated through the existing generation facility, the natural flow variability has been reduced. This alteration of flow forms part of the baseline compared to natural conditions, flows in the Churchill River are now higher in winter and lower in late spring and summer. This has resulted in a less variable flow regime over the course of the year, both seasonally and monthly. ***As the storage is upstream from the Project, there will be minimal changes to downstream flow***.

Volume IIa (page 4-37) states:

- During the last stages of construction when the reservoirs are filled, there will be an estimated 33 to 37 days for Gull Island (Year 6) and 10 to 12 days for Muskrat Falls (Year 9) when downstream flows will be interrupted. ***Once the reservoir is filled, full flows will resume***.

In addition, Hatch 2000a (page 5-4) states:

- Once impoundment is complete (approximately one month after closure), ***the normal river flow will be restored***.

This gives the impression that the Churchill River hydrography will remain essentially unchanged except during the periods of reservoir filling. Consequently, it is my conclusion that the distributions of temperature and salinity in Goose Bay, Lake Melville, and Hamilton Inlet will be unaffected by normal dam operations. The EIS does not address the case in which the river flow does change.

In addition, **the EIS does not discuss possible changes in other water properties**. The numerical modeling studies that Nalcor cites cannot be used to address this issue since the model does not extend seaward beyond the southernmost part of Lake Melville. In any case, an increase in mercury concentration would be cumulative, and would require some time to reach unacceptable levels. Existing data and knowledge about water properties and circulation in the Goose Bay – Hamilton Inlet system is very limited, and there are no known useful models for it. Consequently, it would require considerable effort by Nalcor to address this issue. The same limitation would also apply if Nalcor decided to significantly alter the hydrography.

The EIS states that sediment transport below Muskrat Falls should be much reduced implying that the amount of sediment exported into Goose Bay should be smaller. I was unsure if their conclusion included silt, and I am not qualified to comment on their hydrological models.

Transient Effects

- Nalcor considers a single transient effect, namely, the intrusion of salt water into Goose Bay and the Churchill River during the filling of the reservoir upstream of the Gull Island facility. From the magnitude of the effects predicted at the river mouth, they infer that there will be no significant transient effects in the Lake Melville – Hamilton Inlet system. **This is a logically unsound conclusion**. First, as previously mentioned, the model they use extends seaward only as far as the southern part of Lake Melville. There, it is constrained to have temperature and salinity fields identical to their normal (i.e., predevelopment) values. It would thus be impossible for the model to predict any changes outside Goose Bay. **Their modeling exercise does not estimate changes in the receiving basins, and is simply not applicable to the question of changes away from the river mouth.**

- However, one should expect some changes. The reduction in river discharge during filling (about 5×10^9 m^3) is approximately 2.5 times the volume of the Goose Bay upper layer (25 km x 15 km x 5 m = 2×10^9 m^3). In the absence of river discharge, one can expect the estuarine circulation in the system to partially shut down (there will still be fresh water input from other sources). This implies that both Goose Bay and Lake Melville should become more salty during the filling period. The question is by how much. **Nalcor needs to discuss this issue directly and logically**.

- Moreover, there are questions of the validity of the Hatch (2008a) predictions of salinity and temperature within Goose Bay. The model is validated in its barotropic mode (read essentially depth independent) for sea surface elevation against observed levels in the Churchill River. It was apparently not run in its baroclinic mode (read depth dependent), so **its predictions of depth varying distributions of temperature, salinity, and currents, cannot be accepted**. There exist time series of depth profiles of currents which could be used for validation. Finally, the discussion of model boundary conditions does not indicate what conditions were used to specify velocity.

Deficiencies

1. If Nalcor does not allow for an unchanged river flow, then they have not addressed long-term changes in the temperature and salinity distributions and the circulation in Goose Bay, lake Melville, and Hamilton Inlet.
2. Nalcor has not addressed possible long-term changes in the distribution and concentrations of dissolved chemicals in the Goose Bay – Hamilton Inlet system.

3. Nalcor has not addressed transient effects associated with reservoir filling except for those near the Churchill River mouth. Their assertion that their modeling study shows that there will not be changes away from the river are logically unsound.
4. The hydrodynamic model must be verified in its baroclinic mode before any model simulations of the depth dependent temperature, salinity, and current fields can be accepted.

APPENDIX 8: COMMENTS PROVIDED BY BOB GREGORY

Water and Water Quality

Report # of 5	Title
1	Water and Sediment Modeling in the Lower Churchill River; Minaskuat Inc. 2008
2	Water and Sediment Quality in the Lower Churchill River; Minaskuat Limited Partnership 2007
3	Sedimentation and Morphodynamics Study; Northwest Hydraulic Consultants 2008
4	Water and Sediment Quality of the Churchill River; Jacques Whitford 1999
5	Water Quality and Chlorophyll Study; Jacques Whitford 2000

4.4.4.2 AQUATIC ENVIRONMENT

4.4.4.2 (f) AQUATIC AND RIPARIAN VEGETATION

Aquatic Vegetation Study. AMEC Earth and Environmental Limited. 2008.

- This study was designed to collect information on the fish habitat where aquatic plants grow, to describe habitat features and to determine if new habitats might be created once the reservoirs are formed.

- Plant species were investigated and described for large areas of aquatic habitat, as well as substrate (the material on which the vegetation grows) and sub-surface conditions. Available information was reviewed. Aerial photos were used to identify plant locations and classify plant and substrate types.

- Locations of aquatic plant groups were generally characterized by shallow water of low velocity, shelter from strong currents, and fine substrates such as sand or silt. Common submergent and emergent species were identified and a small number of rare or potentially rare specimens were found.

- How these plants contribute to fish habitat is discussed in the Fish and Fish Habitat Study.

Comment:

- The study findings appear complete. The survey was conducted at a reasonable time of year to detect growth of both riparian and aquatic plants. It seems clear that most of the habitats investigated will be inundated and lost to the aquatic environment for the foreseeable future. Aquatic vegetation, though limited relative to the surface area of the watershed, nevertheless provides cover for some fish species where it does occur.

- The vast majority of this habitat will be lost immediately upon filling each relevant reservoir and be lost for a period of years. It may be that the loss is effectively permanent. If so, this fact should be clearly stated.

- In referencing back to the main EIS document (Vol. IIA, Section 2), no reference to "recovery time" could be found (i.e., re-establishment of communities given new water levels and flow regimes). This would be useful to determine the duration (years) of the impacts of loss of much of this habitat, the most extensive of which occurs in small flood plains at the mouths of many of the tributaries. It should be possible to model these with suitable hydrological data sources which may already exist or could be estimated from other dam developments.

WATER QUALITY AND QUANTITY

4.4.4.2 (c & d) WATER AND SEDIMENT QUALITY

WATER AND SEDIMENT QUALITY IN THE CHURCHILL RIVER
Minaskuat Limited Partnership. 2007.

- This 2006-07 study replicates, to a degree, a study done in 1998 to obtain water and sediment samples from the river. There were some modifications. While the Study Area is identical, the number of sampling stations was reduced (to 10). Sampling was conducted over a complete 12-month cycle by helicopter rather than boat, and 14 recording thermistors were used at Winokapau Lake.

- Water quality (little changed since 1998) is good, with nearly neutral pH; dissolved solids concentrations, dissolved organic carbon and conductivity are all low, as are trace elements, although higher concentrations of aluminum and iron were noted in lower sections of the river. Water chemistry varies along the length of the river, especially during spring melt.

- A single sediment sample was taken in both surveys. Sediment composition and quality have changed little since 1998. Sediments are predominantly sand, and quality is relatively uniform in all sections except at Winokapau Lake, which are typically siltier with higher concentrations of trace elements, nutrients and carbon.

Comment:

- The study findings appear appropriate though limited in scope. Although sediment quality may be somewhat stable in time, this is not the case for water quality, which can change rapidly. There is concern that the one-year nature of the sampling may not reflect interannual variance. For example, it is not clear at all if 2006-07 was or was not a "typical" year (e.g., seasonal rainfall, snowpack, spring melt, ice-out, and ice-in). This is especially significant in the application of these data to the modeled inferences in other study components.

WATER AND SEDIMENT MODELING IN THE LOWER CHURCHILL RIVER
Minaskuat Inc. 2008.

- This study, through simulation modeling, projected the nutrient and sediment levels in the Churchill River post-impoundment. The limiting nutrient in most water bodies is phosphorous.

- The lower Churchill River was divided into eight reaches, where average concentration of total suspended sediment (TSS) and total phosphorous were modeled in surface water, deep water, and bottom sediment. Concentrations of both were predicted to have similar annual cycle's post-impoundment, with elevated concentrations during ice-free

periods and rapid decreases to near-baseline during periods of ice coverage. Long-term trends followed the model erosion rate.

- Modeled concentrations peaked in the two years post-impoundment and by the end of the 20-year scenarios had reached near equilibrium.

Comment:

- This component was thorough and complete in its general approach. The TSS loads with respect to the dam structures also make intuitive sense, and seem consistent with other developments of which I am somewhat familiar. TSS maxima in the order of 120-130 mg/l are not unusual.

- The main deficiency in the study appears to be in the scope of the input data, not how they are used in the modeling efforts themselves. Despite the long term scope of the modeling inferences, a concern is that the one-year nature of the sampling likely does not reflect interannual variance. Again, it is not clear if 2006-07 was a "typical" year and serves as an effective baseline (e.g., seasonal rainfall, snowpack, spring melt, ice-out, ice-in).

- Changing TSS loads will potentially affect fish physiology and it will certainly affect the behaviour of some species. These affects will also likely be life-stage specific. These aspects need to be more fully identified in the EIS main document.

SEDIMENTATION AND MORPHODYNAMICS STUDY.
Northwest Hydraulic Consultants. 2008.

- This study collected information about the form and structure of the river bank, the movement and build-up of sediment, and the formation of river features. This data was used to predict, through computer modeling, changes in the movement of sediment caused by the Project.

- Two scenarios were adopted. Both indicated the proposed Muskrat Falls dam will intercept sediment coming from upstream, resulting in a sediment deficit and general bed degradation downstream. This might induce a shift in channel pattern and increase the rates of bank erosion; this, however, would tend to reduce the extent of bed degradation by increasing the rate of sediment supply.

- These results will allow the Project to plan for mitigative measures such as increased erosion protection and stabilization measures.

Comment:

- This component was thorough in its general approach. The transition from a braided to a meandering river downstream of the development and its implications for the aquatic environment and the aquatic fauna needs to be more fully described and commented on in the main EIS document. This could be a significant influence, as braided rivers tend to provide for more juvenile fish habitat than meanders, by virtue of their more numerous side and back channels and sheltered shallows and current regimes.

WATER & SEDIMENT QUALITY OF THE CHURCHILL RIVER.
JWEL (Jacques Whitford Environment Limited). 1999.

- This report documented the results of water and sediment quality studies conducted in the Churchill River, and in selected tributaries. The study area included the main channel of the Churchill River from its mouth near Goose Bay, upstream to Churchill Falls. A total of 40 water and sediment sampling stations were included. Eight stations were distributed along the length of each of five sections; two additional stations were located at one station within each section to provide a transect across the river. A major tributary was also sampled within each section of the river.

- Water samples were collected at monthly intervals in July, August, September and October, 1998. Most sediment samples were collected during July 1998; samples from deep sites in Winokapau Lake were collected during October 1998. In addition, water temperature monitoring stations were established at seven locations along the length of the river during July 1998. These stations recorded water temperatures until July 1999.

- The river water was found to be generally well mixed, except in Winokapau Lake, where weak thermal stratification was observed during July and August. Chemical stratification was not observed in running water portions of the river, and was weak in Winokapau Lake.

- Water quality was generally dilute, as is typical of waters draining the Canadian Shield. Major cation concentrations were very low, as were total dissolved solids concentrations, dissolved organic carbon and specific conductance. The pH was generally near neutral. Nutrient concentrations (phosphorus and nitrogen compounds) were generally not detectable, indicating that the river is likely to have low productivity. Overall, the water quality of the Churchill River was very good when compared with Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life.

- Overall, sediment quality was very good and only nickel concentrations in portions of Winokapau Lake exceeded probable effect levels as defined in the Interim Canadian Sediment Quality Guidelines.

Comment:

No comments.

WATER QUALITY AND CHLOROPHYLL STUDY
JWEL (Jacques Whitford Environment Limited). 2000.

- In 1999, a water and chlorophyll study was conducted to characterize baseline conditions in lakes and reservoirs of the Churchill River system. The focus was on surface and deep-water quality as well as chlorophyll, phytoplankton and zooplankton to describe and quantify production levels in these lakes.

- Phytoplankton composition in the Churchill lakes was dominated by nanoplankton forms similar to the communities at La Grande and Cat Arm but different from those at Southern Indian Lake where large colonial diatoms and blue-green filamentous algae frequently dominated. Summer phytoplankton biomass concentrations in the Churchill lakes were comparable to those at Cat Arm and La Grande, all of which were lower than those observed in Southern Indian Lake.

- Primary production in the Churchill lakes was greater than that in Cat Arm Reservoir where low light penetration severely restricted the photosynthetic zone, and was comparable to pre- impoundment production at La Grande. The primary production rates of all of these systems were much lower than pre- and post-impoundment levels in Southern Indian Lake. Specific production rates in the Churchill lakes were lower than at La Grande and Southern Indian Lake, which may be indicative of a greater degree of nutrient stress.

- Zooplankton communities in the Churchill lakes were dominated by cladocera with calanoid copepods sub-dominant, similar to the communities observed in Cat Arm Reservoir and in the La Grande complex but quite different from Southern Indian Lake where cyclopoid copepods predominated with calanoids sub-dominant. Biomass levels in the lentic lakes of the Churchill watershed were comparable to preimpoundment levels at La Grande but lower than post-impoundment levels at Cat Arm Reservoir. Biomass data are not available for Southern Indian Lake.

- Mercury concentrations in water were determined to be comparable to those determined for Quebec reservoirs for total mercury, and somewhat lower for methylmercury as all samples from the Churchill River lakes returned results below detection. Similarly, the mercury levels determined for zooplankton were within the range of those found in Quebec reservoirs and natural lakes.

Comment:

No comments.

HYDROLOGY

SEDIMENT PLUME ANALYSIS
Hatch. 2008.

- This 3-D hydraulic modeling study estimates the potential and extent of sediment plumes associated with construction of the Gull Island and Muskrat Falls facilities.

- The composition of suspended material and an estimate of distance to deposition downstream of the construction sites were modeled.

- Sediment loading rates in depositional areas were calculated for different phases of construction.

Comment:

- This component was thorough in its general approach. However, there was no relation of this information in the EIS as it relates to the aquatic fauna. This is a gap.

- Again changing TSS loads will potentially affect fish physiology and it will certainly affect the behaviour of some species. These affects will also likely be life-stage specific. These aspects need to be more fully identified in the EIS main document.

BANK STABILITY STUDY
AMEC Earth and Environmental Limited. 2008.

- This study assesses the potential effects of the Muskrat Falls and Gull Island reservoirs on the new shoreline and river banks, with particular respect to its effects on fish habitat and sediment loading.

- The collected data, including geological reports, wind data, aerial photos and digital images, were used to classify slope, soil and vegetation cover, and stability, and to model existing and future shorelines. Existing shoreline was rated on terrain stability, erosion potential and wave energy; these ratings were incorporated into a GIS program to produce a map that identifies potential areas of shoreline erosion.

- The study concluded that raising the water levels will result in a more stable shoreline where lithology is homogeneous (e.g., at the Gull Island Reservoir), while within layered lithologies (e.g., Muskrat Falls) the shoreline will be less stable.

Comment:

- This component seems to have been thoroughly conducted to me. No specific comments.

Review of Water Quality and Chlorophyll Report – 1998 Draft Report

- This report was reviewed and found to supply good baseline data for the Churchill River system.

- Under the latest 'project description' for the lower Churchill hydro project, more effort maybe warranted in Winokapau Lake. One sampling station within this large body of water is not sufficient to characterize the plankton populations which are known to be patchy in their distributions. In addition to this comment, it is of interest to note that both the Winokapau and the Gull stations had differing seasonal patterns in chlorophyll concentrations and lower zooplankton biomasses. This is most likely related to their high flushing rates. Within the proposed reservoir flushing rates would remain high so it is possible that this would work to reduce the trophic upsurge expected from reservoir creation.

APPENDIX 9: COMMENTS PROVIDED BY MIKE O'CONNELL

Comments supplied by this reviewer during the plenary of the meeting will be submitted to DFO Habitat Protection Division as a part of an extensive review of the EIS and supporting component studies.